ANNEX F

PHOSPHORUS ASSESSMENT FOR WCA-3 AND ENP

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

F ASSESSMENT OF TOTAL PHOSPHORUS CHANGES IN WCA- 3 AND ENP THAT RESULT FROM IMPLEMENTATION OF THE CEPP PROJECT (SFWMD/USACE 07.18.13)

F.1 INTRODUCTION

This report presents a qualitative analysis of water quality impacts to the WCA-3 and ENP as a result of implementing the Central Everglades Planning Project (CEPP). This assessment focuses on ALT4R; however, ALT4R2 is the Tentatively Selected Plan (TSP). Given the similarities between these two alternatives the impact to water quality are expected to be very similar. Also, since this is a qualitative analysis, the findings presented here are generally applicable to the other with-project alternatives such as ALT1, ALT2, and ALT3. The CEPP will substantially alter the timing, quality, quantity, and distribution of water flows to Water Conservation Areas (WCAs) 3A and 3B and Everglades National Park (ENP or Park). ALT4R and ALT4R2 (**Figure F-1**) includes major features that improve flows through the WCA 3A and 3B such as an additional Flow-Equalization Basin (A-2 FEB) in the Everglades Agricultural Area (EAA), a partially backfilled Miami Canal in northern WCA-3A, degrade of the L-4 levee to distribute water in northwestern WCA-3A, and construction of structures to improve water deliveries into WCA-3A and WCA-3B including the construction of the Blue Shanty Flow-way in western WCA-3B. Additional ALT4R features improve inflow at the northern boundary of ENP. Such features include a partial degrade of the L-29 levee allowing the Blue Shanty Flow-way to discharge into the Park, increasing S-333 and S-356 flow capacities, seepage management features, L-67 Extension Canal Backfill, and Old Tamiami Trail removal.

As required by the Everglades Forever Act (EFA), the State of Florida developed and implemented a total phosphorus (TP) water quality criterion [Rule 62-302.540, Florida Administrative Code (F.A.C.)] for the Everglades Protection Area (EPA). The EPA includes the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge, also known as WCA-1), WCA-2, WCA-3, and ENP. The criterion, as it is applied to the WCAs, is expressed as a long-term geometric mean of 10 micrograms per liter (µg/L), or parts per billion (ppb) TP. Compliance with the criterion for ENP is determined via the methods set forth in Appendix A of the 1991 Settlement Agreement (Case No. 88-1886-Civ-Moreno). As the with-project alternatives (ALT1, ALT2, ALT3, ALT4, ALT4R, and ALT4R2 are expected to have beneficial impacts on water quality in WCA-3A, but minimal impact on water quality within WCA-1 and WCA-2, these portions of the EPA are not discussed in this paper. Additionally, no analysis of water quality impacts to Taylor Slough inflows to ENP is presented as the with-project alternatives are expected to have minimal impacts to flow and water quality conditions within the C-111 basin.

F.2 NORTH OF THE REDLINE (EVERGLADES AGRICULTURAL AREA)

Since EFA implementation, the state has established numeric criteria for TP throughout the EPA, required the implementation of agricultural Best Management Practices (BMPs) to reduce phosphorus levels in farm discharges and constructed, operated, and maintained massive manmade treatment wetlands known as the Everglades Stormwater Treatment Areas (STAs). Over the past 2 decades, the South Florida Water Management District (SFWMD or District) has operated STAs to substantially reduce TP concentrations in water being delivered to the WCAs. The effective treatment area of STAs has increased from approximately 4,000 acres in 1994 to 57,000 acres as of today. While the construction and operation of the STAs have substantially improved the quality of water discharged to the WCAs, both the federal and state parties to the Settlement Agreement acknowledge that additional reductions are necessary.

In early 2010, the SFWMD, State of Florida, and USEPA began technical discussions to establish a Water Quality Based Effluent Limit (WQBEL) for TP discharges from the Everglades STAs that would achieve compliance with the state's numeric TP criterion in the EPA and to identify a suite of additional water quality projects to work in conjunction with existing STAs to meet the WQBEL. From these discussions, in 2012, the FDEP issued a National Pollutant Discharge Elimination System (NPDES) Watershed Permit and an associated Consent Order and an EFA Watershed permit and associated Consent Order, establishing the WQBEL, the suite of water quality improvement projects to be constructed under the Restoration Strategies Program, and the compliance schedules for those projects.

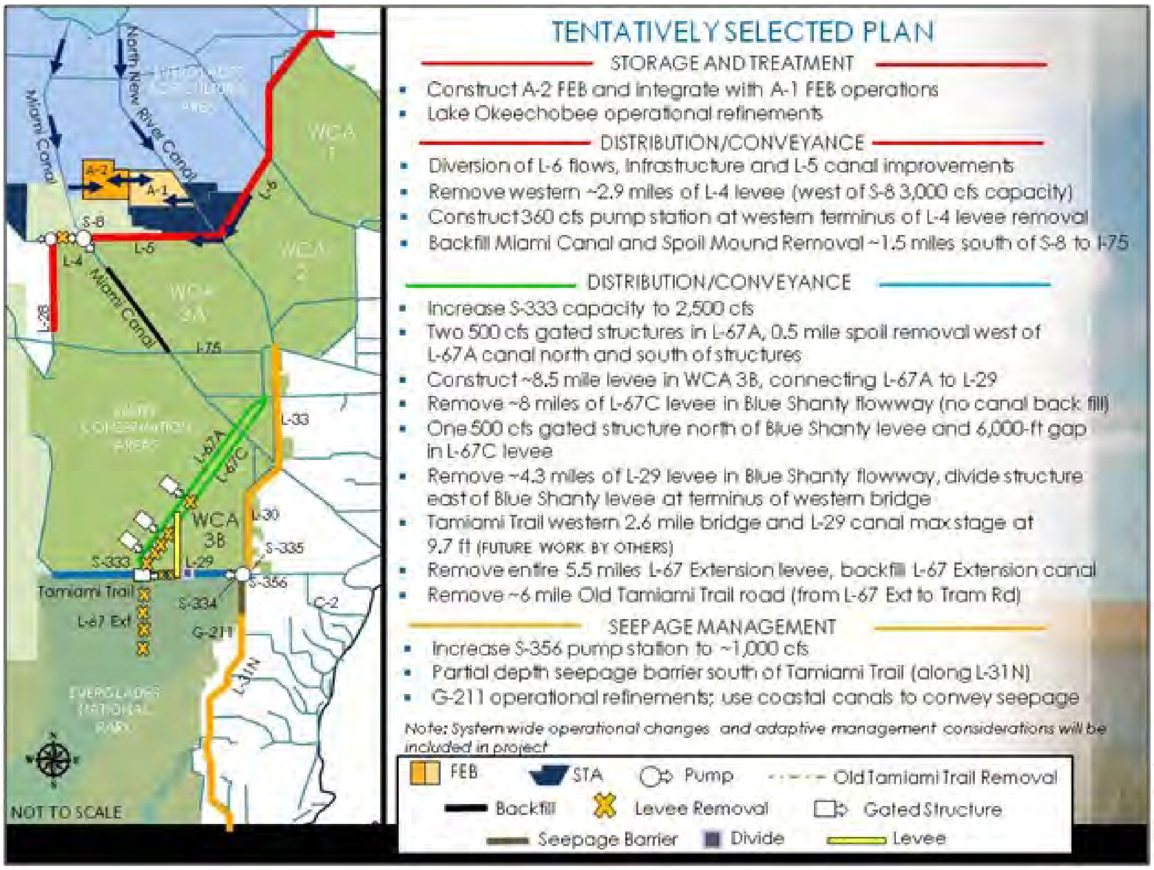


Figure F-1. Map and description of the Tentatively Selected Plan (TSP) (ALT4R).

These permits establish a WQBEL for TP in which STA Discharges shall not exceed 13 parts per billion (ppb) as an annual flow-weighted mean (FWM) in more than three out of five years on a rolling basis (Part 1), and shall not exceed 19 ppb as an annual FWM in any water year (Part 2). The State and USEPA agreed that achieving these limits would ensure that the STA discharges do not cause or contribute to exceedances to Florida's water quality standard for TP in the Everglades. The State and USEPA also agreed to a suite of additional projects which includes constructing 6,500 acres of STAs and 110,000 acre-feet of water storage, or Flow-Equalization Basins (FEBs). Additionally, the plan includes enhancements to existing conveyance features and STAs. **Figure F-2** shows the components of the Restoration Strategies Regional Water Quality Plan tagged with white labels; the existing STA facilities are shown in green. The Central Flow

Path includes A-1 FEB, STA-3/4, and STA-2. Additional detail on the Restoration Strategies Regional Water Quality Plan is available at www.sfwmd.gov/restorationstrategies.

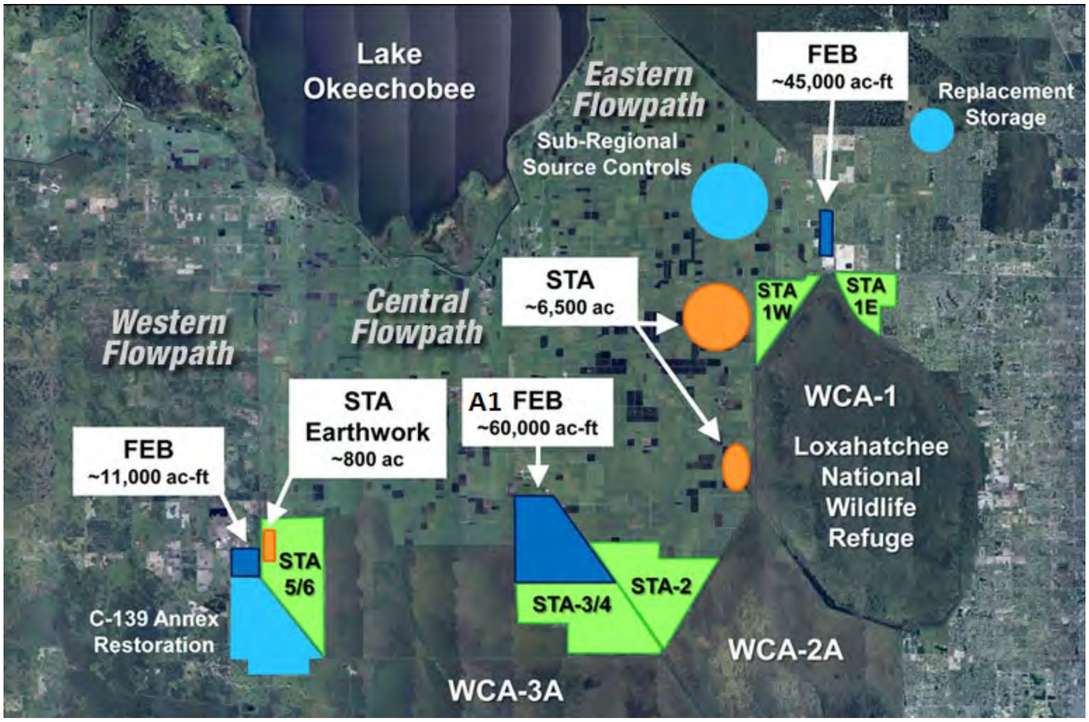


Figure F-2. Restoration Strategies (RS) key projects in Eastern, Central, and Western Flow Paths.

In order to deliver the additional flows anticipated under the CEPP, water will be delivered through the Central Flow Path down the Miami and North New River canals. These canals are the main north-south conduits connecting Lake Okeechobee and upstream basins to WCA-3A. These additional flows must be treated prior to entering WCA-3A to maintain compliance with water quality standards. ALT4R will most likely have minimal effect on the Eastern or Western Flow Paths. Since the delivery of additional flows under the CEPP is reliant upon the existing STAs and Restoration Strategies project features for water quality treatment, CEPP project features that redistribute existing flows and/or deliver additional flows cannot proceed unless/until it is determined that construction and/or operation of the feature 1) will not cause or contribute to a violation of water quality standards; 2) will not cause or contribute to a violation of the permit(s) discharge limits or specific conditions; and, 3) reasonable assurances exist that demonstrate adverse impacts on flora and fauna in the area influenced by the project element will not occur. Compliance with WQBELs for the STAs cannot be determined until all corrective actions have been completed. Compliance with the WQBEL shall be determined based on the conditions contained within the NPDES permit (FL0778451), EFA permit (0311207), NPDES Consent Order (12-1148), and EFA Consent Order (12-1149).

ALT4R2 proposes the A-2 FEB with an approximate capacity of 60,000 ac-ft to allow for additional inflows to the Central Flow Path. Alt 4R will also rely on several SFWMD-owned/operated facilities, such as the A-1 FEB for storage and STA-2 and STA-3/4 for treatment. **Figure F-3** depicts the A-2 FEB and the state's A-1 FEB, which will both be operated as an integrated facility under CEPP (A-1/A-2 FEB). The S-628 divide structure will allow water to be routed from the A-1 FEB to the A-2 FEB depending upon available capacity. Flows from the A-1/A-2 FEB can be delivered to the Miami and North New River Canals and to STA-2 and STA-3/4 when capacity or operational desires exist. During CEPP plan formulation, a dedicated storage and treatment facility for CEPP was screened out because it was not deemed cost effective. It is not anticipated that dedicated water treatment facilities for CEPP will be warranted. This estimation may be reassessed as identified in the Adaptive Management Plan once facilities are built and water quality compliance is evaluated. Additional details regarding the integrated operation of the A-1/A-2 FEB are presented in the Draft Project Operating Manual (DPOM).

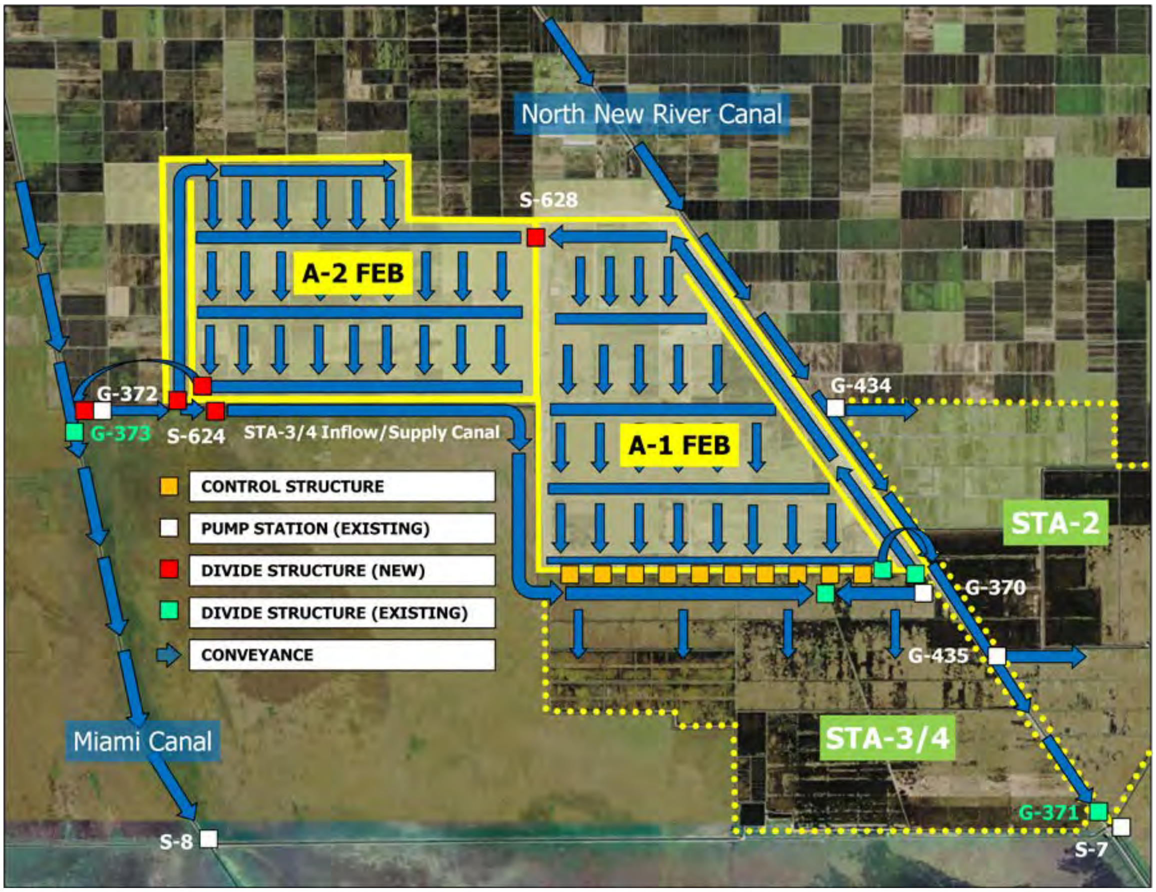


Figure F-3. Integrated A-1/A-2 FEB component of the CEPP.

DMSTA2 modeling predicted the TP removal performance of the integrated A-1/A-2 FEB, STA-2, and STA-3/4 facilities. The A-1 FEB was included in the future without (FWO) project conditions, as it will be operational before the CEPP features are constructed. The DMSTA2 model assumed the phosphorus removal performance of the A-1 FEB was that of emergent aquatic vegetation (EAV). This assumption is based on the anticipated establishment of native marsh vegetation due to the hydrologic conditions expected at the site, coupled with proposed vegetation management activities. The following assumptions were incorporated into the DMSTA2 model:

1. Lake Okeechobee TP concentrations were set to the 2000-2009 monthly average from the S-351 and S-354 structures at the Lake rather than at the lower concentrations observed at the STA-2 and STA-3/4 inflow structures.
2. The STA duty cycle factor used in DMSTA2 was set to 0.95, which effectively simulates each STA to be offline for 5 percent of the time.
3. The DMSTA2 modeling was done using the calibration dataset which does not reflect the future improvements in STA removal efficiency that are expected from Restoration Strategies operational refinements.
4. To allow for additional vegetation management flexibility within the STAs, a resting period of 45 days, scheduled every three years was incorporated into the DMSTA2 operational scheme for STA-3/4. STA resting periods are intended to simulate conditions during the dry season that allow vegetation rejuvenation and expansion, which will sustain vegetation health and maintain treatment performance.
5. Due to the uncertainty associated with DMSTA-simulated low level TP concentrations, annual values less than 12 ppb were replaced with a value of 12 ppb.

DMSTA2 modeling results are provided below in **Figure F-4** and **Table F-1**. The difference in average monthly flows between with CEPP and FWO project conditions are shown in **Figure F-4** and the seasonal distribution of those flows are shown in **Table F-1**. Note that RS_FEB34 includes the A-1 FEB only (FWO), and the CEPP_FEB34 represents ALT4R with the integrated A-1/A-2 FEB. **Figure F-4** shows that with the additional monthly CEPP flows in the Central Flow Path, most of the additional flow (WTRSHD_DIFF) occurs during the dry season, November through May. CEPP increases the percentage of annual flows occurring during the dry season through the Central Flow Path, FEB, and STAs (**Table F-1**). CEPP additional flows to the watershed are relatively small during the wet season (20 kac-ft) as compared to the dry season (234 kac-ft). CEPP (A2) also provides additional capacity for storing and treating wet season runoff from the S8/S7 basins that would occur regardless of additional Lake Okeechobee releases. CEPP also reduces the runoff volume and load by reducing the watershed area (A2). This will increase the probability of achieving the WQBEL with or without additional flow from the Lake.

Historical observations suggest that STA phosphorus removal efficiency may be lower during the dry season and this pattern is likely associated with multiple components of internal phosphorus cycling. Lower temperatures, fewer hours of daylight, STA dryout, reduced algal and plant growth, changes in microbial growth and decomposition, increased herbivory by avian species, and the overall decrease in biological activity that exist in the dry season may all impact an STA's ability to retain phosphorus. In addition to these contributing factors, stagnant or non-flowing conditions that can occur for several weeks during the dry season within the STAs and the resultant increase in upward flux of phosphorus are also hypothesized to affect STA outflow phosphorus concentrations. Accordingly, moderate STA inflows during the dry season may enhance an STA's ability to retain phosphorus from the sediment during the dry season. While uncertainty remains about the performance of STAs in the dry season, future implementation of flow equalization basins, as proposed by CEPP (and previously by Restoration Strategies), paired with appropriate STA resting periods and vegetation rejuvenation and management activities, should ultimately assist in reducing dryout and stagnant conditions and may result in improved dry season STA performance.

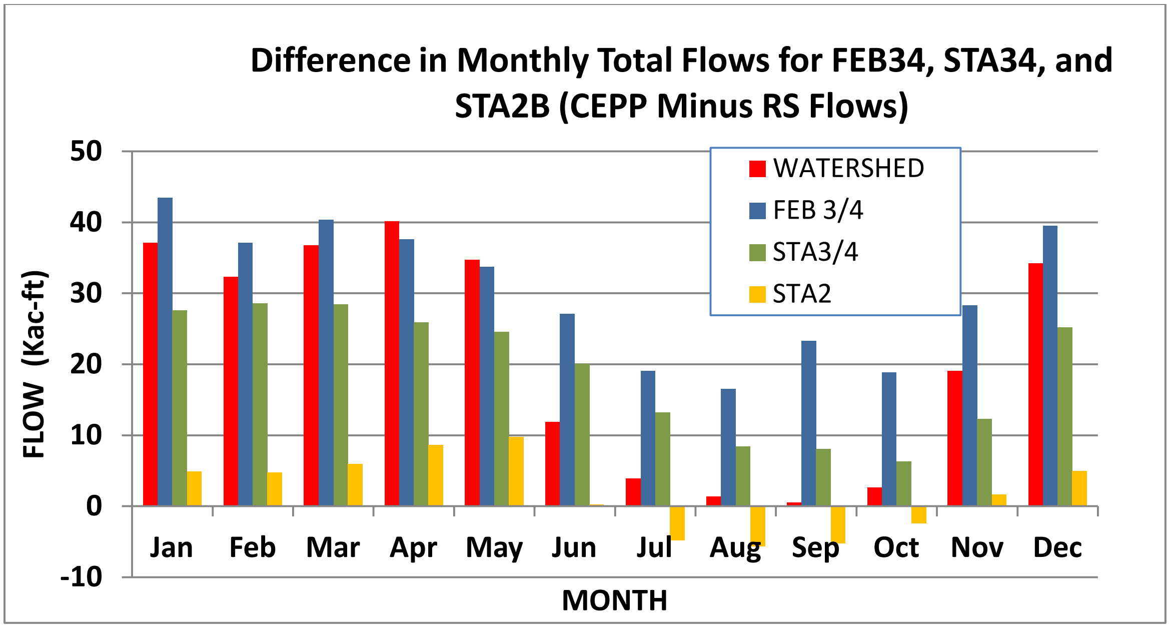


Figure F-4. Difference in average monthly flows for FEBs, STA-3/4, and STA-2 under CEPP and future without (FWO) (RS) project conditions. [Note: Period of record (POR) is 1965 to 2005.]

Table F-1. Annual and seasonal flows for CEPP and FWO (RS) project conditions in the Central Flow Path Watershed, RS_FEB34, CEPP_FEB34, STA-3/4, and STA-2.

Period of Analysis	RS_WTRSHD (kac-ft/yr)	CEPP_WTRSHD (kac-ft/yr)	WTRSHD DIFFERENCE (kac-ft/yr)	RS_FEB34 (kac-ft/yr)	CEPP_FEB34 (kac-ft/yr)	FEB34 DIFFERENCE (kac-ft/yr)
Average Annual Flow (May 1 to April 30)	803	1058	255	276	641	365
Dry Season Flow (Nov 1 through May 31)	270	505	234	95	355	260
Wet Season Flow (June 1 through October 30)	533	553	20	180	285	105
Dry Season Percent of Annual Flow	34%	48%	14%	35%	55%	20%
Wet Season Percent of Annual Flow	66%	52%	-14%	65%	45%	20%
Period of Analysis	RS_STA34 (kac-ft/yr)	CEPP_STA34 (kac-ft/yr)	STA34 DIFFERENCE (kac-ft/yr)	RS_STA2B (kac-ft/yr)	CEPP_STA2B (kac-ft/yr)	STA2B DIFFERENCE (kac-ft/yr)
Average Annual Flow	408	637	229	392	415	23
Dry Season Flow	137	310	173	122	163	41
Wet Season Flow	272	328	56	270	252	-18

Note: RS_FEB34 is the A-1 FEB, CEPP_FEB34 is the integrated A-1/A-2 FEB

Table F-2 shows the estimated performance of the A-1/A-2 FEB, STA-2 and STA-3/4 for the with CEPP and FWO condition based upon DMSTA modeling. The implementation of CEPP will reduce the predicted period of record FWM TP concentrations from STA-2 and STA-3/4 when compared to the FWO condition. **Table F-2** also shows that the ALT4R will increase the A-1/A-2 FEB annual inflow volumes and TP loads as compared to FWO in part by reducing the flows that are sent directly to STA 3/4 and STA 2. There are increases in load removal in STA 2 and STA-3/4. The CEPP project will also reduce the annual diversion volumes and TP loads around STA-2 and STA-3/4. The CEPP will increase the unit area TP loading to the A-1/A-2 FEB by 55 percent, STA-2 by 3 percent, and STA-3/4 by 12 percent over the FWO condition. Increased TP loading under the with CEPP condition to the A-1/A-2 FEB, STA-2, and STA-3/4 is expected to increase the frequency in which these facilities will require maintenance to structures and the removal of accumulated sediments to maintain hydraulic capacity.

There are potential risks associated with treatment of CEPP flows using the existing conveyance features, STA facilities, and portions of the A-1 FEB capacity. For instance, it is possible that the STA/FEB system may be less efficient at removing TP than predicted by the DMSTA2 modeling presented here. There is also uncertainty about whether the A1/A2 FEB can effectively operate with single pumps used for inflows and outflows. If this operation scheme proves unworkable, structural or operational changes may be required. As the A-1 FEB, and other Restoration Strategies projects, will be constructed and operational for several years before the design of the A-2 portion of the integrated A-1/A-2 FEB, there should be sufficient time for the SFWMD to evaluate system performance and initiate structural or operational changes prior to finalizing design of the A-2 FEB features. An adaptive management plan has been developed for the CEPP to address some of the uncertainties associated with operating the A-1/A-2 FEB as an integrated system.

Table F-2. DMSTA2 predicted hydrologic and water quality performance under FWO and Alt 4R2 conditions in the Central Flow Path.

Performance Measures	Facilities	FWO (RS*)	ALT4R	Difference (CEPP - RS)	Percent Change
		A-1 FEB	A-1/A-2 FEB		
FWM Outflow TP Concentration (ppb) - Facility Outflow Only (No Diversions)	FEB 34	23.6	32.1	8.5	36%
	STA-2**	12.4	11.5	-0.9	-7%
	STA-3/4**	11.6	10.9	-0.7	-6%
Average Annual Inflow Volumes (kac-ft/yr)	FEB 34	276	641	365	132%
	STA-2	392	414	22	6%
	STA-3/4	408	637	229	56%
	STA-2 + STA-3/4	800	1051	251	31%
Average Annual TP Load Reduction (mt/yr)	FEB 34	24.1	66.7	43	176%
	STA-2	47.2	48.7	1.5	3%
	STA-3/4	23.8	24.4	0.6	3%
	FEB + STAs	95.2	139.8	44.6	47%
Average Annual Volumes Directly to STAs(kac-ft/yr)	STA-2 + STA3/4	167	76	-91	-54%
Average Annual Untreated Diversion Volumes (kac-ft/yr)	STA-2	5.4	4.9	-0.5	-10%
	STA-3/4	5.9	0.8	-5.1	-86%
Average Annual Load Directly to STAs TP Load (mt/yr)	STA-2 + STA3/4	23	11	-12	-53%
Average Annual Untreated Diversion TP Load (mt/yr)	STA-2	0.8	0.7	-0.1	-10%
	STA-3/4	0.7	0.1	-0.6	-89%
Unit Area TP Removal ($mg/m^2/yr$)	FEB 34	428	613	185	43%
	STA-2	849	871	22	3%
	STA-3/4	386	393	7	2%
Unit Area TP Loading ($mg/m^2/yr$)	FEB 34	528	819	291	55%
	STA-2	849	871	22	3%
	STA-3/4	445	497	52	12%

* RS = Restoration Strategies Plan for Central Flow Path
** FWM TP concentrations for STA2 and STA3/4 are adjusted using minimum outfall concentration of 12 ppb.

Note: RS_FEB34 is the A-1 FEB, CEPP_FEB34 is the integrated A-1/A-2 FEB. ac-ft – acre-feet; FEB –Flow Equalization Basin; FWM – flow-weighted mean; mg/m^2 – milligrams per cubic meter; mt – metric tons; ppb – parts per billion; STA – Stormwater Treatment Area; TP – total phosphorus.

** Annual FWM TP concentrations for STA-2 and STA-3/4 are adjusted using minimum annual concentration of 12 ppb due to uncertainty associated with DMSTA2 simulation of low level phosphorus concentrations.

F.3 WATER CONSERVATION AREA 3A (WCA-3A)

WCA-3A receives the majority of its surface water inflow from STA-3/4 and WCA-2. Under Alt 4R, a portion of flows historically routed to WCA-2 will be diverted into WCA-3A. ALT4R2 includes the removal of 2.9 miles of the L-4 levee to create an east-west distribution spreader for inflows along the northwestern boundary of WCA-3. This modification, together with the partial backfill of the Miami Canal from 1.5 miles south of the northern border of WCA-3A to Interstate 75 (I-75), will help introduce sheet flow into the northern WCA 3A marsh. At the southern end of WCA-3A/3B, the Blue Shanty Flow-way will be constructed to divert flows from the L-67A canal into the marsh before it flows across Tamiami Trail into ENP.

F.3.1 Flows and Loads into WCA-3A

The impact of the CEPP on WCA-3A is described below in terms of additional flows and associated concentrations, changes to hydropattern, and TP concentrations within the marsh. **Table F-3** compares the flows and TP loads expected in the Existing Conditions Baseline (ECB), FWO, and ALT4R scenarios at the northern boundary of WCA 3A. These load estimates were developed using historic TP concentrations for ECB and DMSTA2 predicted TP concentrations for FWO and Alt4R at WCA-3A inflow locations and hydrologic flow predictions from the RSMBN and RSMGL regional simulation models. The hydrologic predictions show that FWO flows will be slightly reduced relative to ECB while the ALT4R2 flows will be greater than both the ECB and FWO condition. Relative to FWO, the CEPP (ALT4R) will increase TP loads by approximately 12 percent. Relative to ECB, the CEPP (ALT4R2) will decrease TP loads by approximately 26 percent as well this load will be dispersed across the northern marsh instead of routed down the Miami Canal. The FWM TP concentrations shown in **Table F-1** for the FWO and ALT4R are higher than the WQBEL of 13 ppb because; 1) they were computed using flows and loads from all of the WCA-3A inflows, not just the northern WCA-3A inflows, 2) the lack of historic data prior to 1990 required the use of an average FWM TP concentration applied to the 41 year long simulated flows at several of the structures (S9x, S190, S140 and S11x), and 3) future conditions will likely have lower concentrations at S9x, S190, and S140 than the historic data used here. Even with the likely over-estimated loads, the inflow concentrations into WCA-3A are expected to decrease by one third relative to existing conditions for both the FWO and ALT4R condition. Flows and TP loads for ALT4R2 into WCA-3A are similar to those shown for ALT4R.

Table F-3. Net WCA-3A inflows and loads for ECB, FWO, and ALT4R.

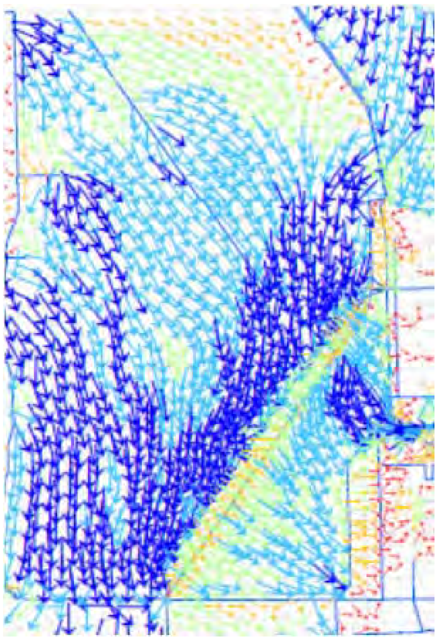
WCA-3A Average Annual Flow (kac-ft/yr)			
	ECB	**FWO**	**ALT4R**
WCA-3A Inflows	1,470	1,400	1,637
Change from FWO	5%	n/a	17%
Change from ECB		**-5%**	**11%**
TP Load Discharged into Northern WCA-3A			
Total Load (mt/yr)	51	34	38
Change from FWO	50%	n/a	12%
Change from ECB	n/a	**-34%**	**-26%**
TP Concentrations Discharged into Northern WCA-3A			
FWM TP Concentration (ppb)	28	20	19
Change from FWO	+ 43%	n/a	- 4 %
Change from ECB	n/a	**-30%**	**-33%**

Notes:

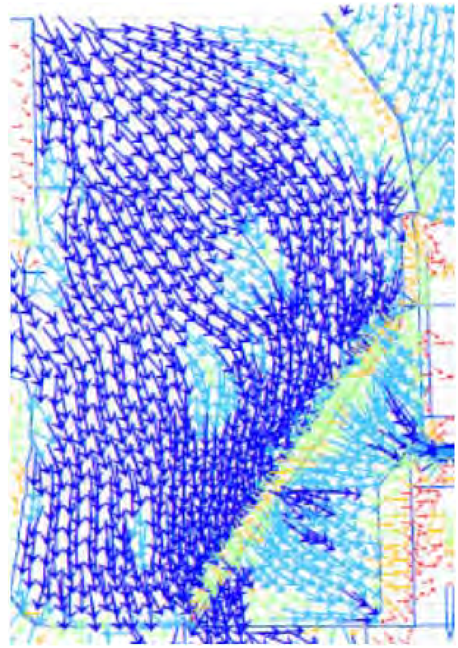
1. Flow volumes are from Regional Simulation Model - Glades *LECSA* (*RSMGL*) model for 41 year simulation period..
2. ECB Average flow-weighted mean TP concentrations applied using available period of record grab sample data ((Northern 3A 2006-2011), S11x (2006-2012), S9x (2003-2012), S140 (2008-2012), S190 (2008-2012) multiplied by daily simulated flows.
3. FWO, ALT4R TP loads for Northern WCA-3A inflows calculated using DMSTA2 predictions adjusted to 12 ppb minimum annual outflow concentration. Estimated loads for the remaining structures were computed using historic period of record FWM TP concentrations applied to the 41 year simulated hydrology.
4. Loads based on flow-weighted mean calculations.

F.3.2 Hydrologic Flow Patterns in WCA-3A

ALT4R will improve the sheetflow distribution and hydroperiod as compared to the FWO conditions as shown in **Figure F-5** and **Figure F-6**, respectively. The flow and hydroperiod patterns for ALT4R2 are similar to ALT4R. Increased sheetflow coupled with longer hydroperiod will likely increase the TP assimilative capacity over time within the northern WCA-3A marsh and decrease TP transport to the southern WCA-3A and ENP. Once the marsh and impacted areas have had time to stabilize from both past hydroperiod alterations and project construction, the risk of downstream TP spikes caused by dry out and rewetting, should be reduced.



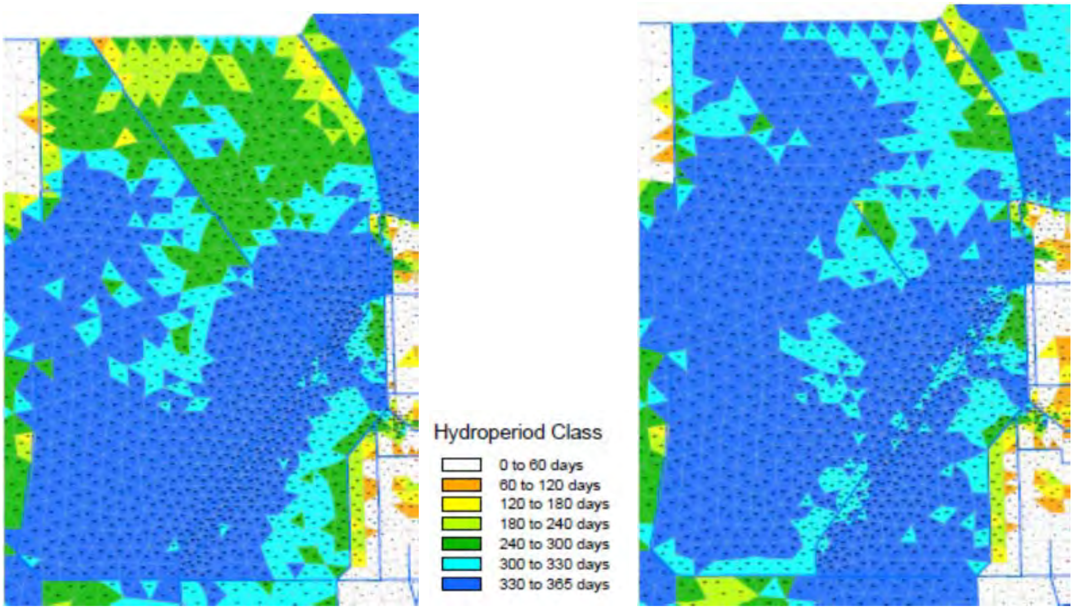
Average FWO Flow Patterns in WCA- 3



Average ALT4R Flow Patterns in WCA-3

Figure F-5. Average flow pattern conditions for FWO (left) and ALT4R (right) in WCA-3.

(Source *Regional Simulation Model Glades-LECSA* (*RSMGL*) CEPP Model Output, Dec. 2012, SFWMD).



Average FWO Hydroperiod in WCA-3 Average ALT4R Hydroperiod in WCA-3

Figure F-6. Average Hydroperiod Conditions for FWO (left) and ALT4R (right) in WCA-3 (Source: RSMGL CEPP Model Output, Dec. 2012, SFMWD).

The ALT4R2 flows that pass through the S-631 structure in the L-67A canal (**Figure F-7**) and into WCA-3B will reduce some of the channelized discharge of S-9 flows to S-333 and S-12D. The S-632 and S-633 structures in the L-67A canal will divert L-67A canal flow into the Blue Shanty flow-way which will be constructed in the southwestern corner of WCA-3B. Discharges will continue through the S-12's and the S-333, but the distribution will change such that S-333 flows will increase. By introducing flows into the WCA-3B marsh and optimizing operations, an increase in TP uptake is expected.

Figure F-7. Proposed WCA-3B infrastructure.

F.3.3 Marsh TP Concentrations in WCA-3A

The state's Phosphorus Rule (Rule 62-302.540, F.A.C) requires the SFWMD to maintain a network of marsh monitoring stations to track changes in soil and water column TP concentrations within the EPA (WCAs and ENP). **Figure F-8** shows the network of monitoring stations within the WCAs. In WCA-3A, four of the marsh stations (CA33, CA35, CA36, and CA314) have been identified as impacted based upon elevated soil phosphorus and water column TP concentrations at these locations.

Achievement of the criterion for the ambient monitoring network is evaluated and determined annually for each WCA based on data collected monthly from a network of ambient monitoring stations in both impacted and unimpacted areas. To achieve the criterion, the following four provisions must be met:

1. The five year geometric mean averaged across all stations is less than or equal to 10 µg/L.

2. The annual geometric mean averaged across all stations is less than or equal to 10 µg/L for three of five water years.

3. The annual geometric mean averaged across all stations is less than or equal to 11 µg/L; and

4. The annual geometric mean at all individual stations is less than or equal to 15 µg/L.

Assessment of TP compliance is usually conducted for each section of the EPA (i.e., Refuge, WCA-1, WCA-2, and WCA-3) annually. However, this section presents the compliance calculation period from Water Years 2008–2012 (WY2008–WY2012) (May 1, 2007–April 30, 2012) for WCA-3 only. Both unimpacted and impacted networks had a slight increase in the average geometric mean TP concentrations in WY2012 (**Figure F-9**). Despite this slight increase, the unimpacted portion of the marsh did not exceed the limits of 10 µg/L (long-term, five-year limit) and 11 µg/L (network limit). Furthermore, all stations within each unimpacted network did not exceed the 15 µg/L annual limit, and only one station (CA36) within the impacted network exceeded the 15 µg/L annual limit (**Figure F-10** and **Table F-4**).

The highest TP concentration was observed at an impacted network station, CA36, which is located in northern WCA-3A near the Miami Canal and the S-339 divide structure. The S-339 structure is usually closed, forcing S-8 discharge water into the marsh at this location. The highest geometric mean TP concentration within the unimpacted network was experienced at station CA3B2 (7.7 µg/L). During WY2012, one of the five impacted stations was below the 15 µg/L annual limit. However during WY2012, due to low water levels, data from three stations had less than six data points (CA324, CA33, and CA35) and, therefore, these stations were excluded in the overall compliance determination. Slightly higher TP concentrations in both impacted and unimpacted portions of the marsh can potentially be explained by the irregular rainfall and dryer than normal start to the water year and wet season.

The results of the WY2008–WY2012 TP criterion assessment (**Table F-4**) indicate that, even with the data limitations, the unimpacted portions of the WCAs passed all four parts of the compliance test (as expected) and are therefore in compliance with the 10 µg/L TP criterion. Occasionally, individual sites within the unimpacted portions of the WCAs exhibited an annual site geometric mean TP concentration above 10 µg/L, as expected, but in no case did the values for the individual unimpacted sites result in an exceedance of the annual or long-term network limits. None of the annual geometric mean TP concentrations for the individual unimpacted sites during the WY2008–WY2012 period exceeded the 15 µg/L annual site limit.

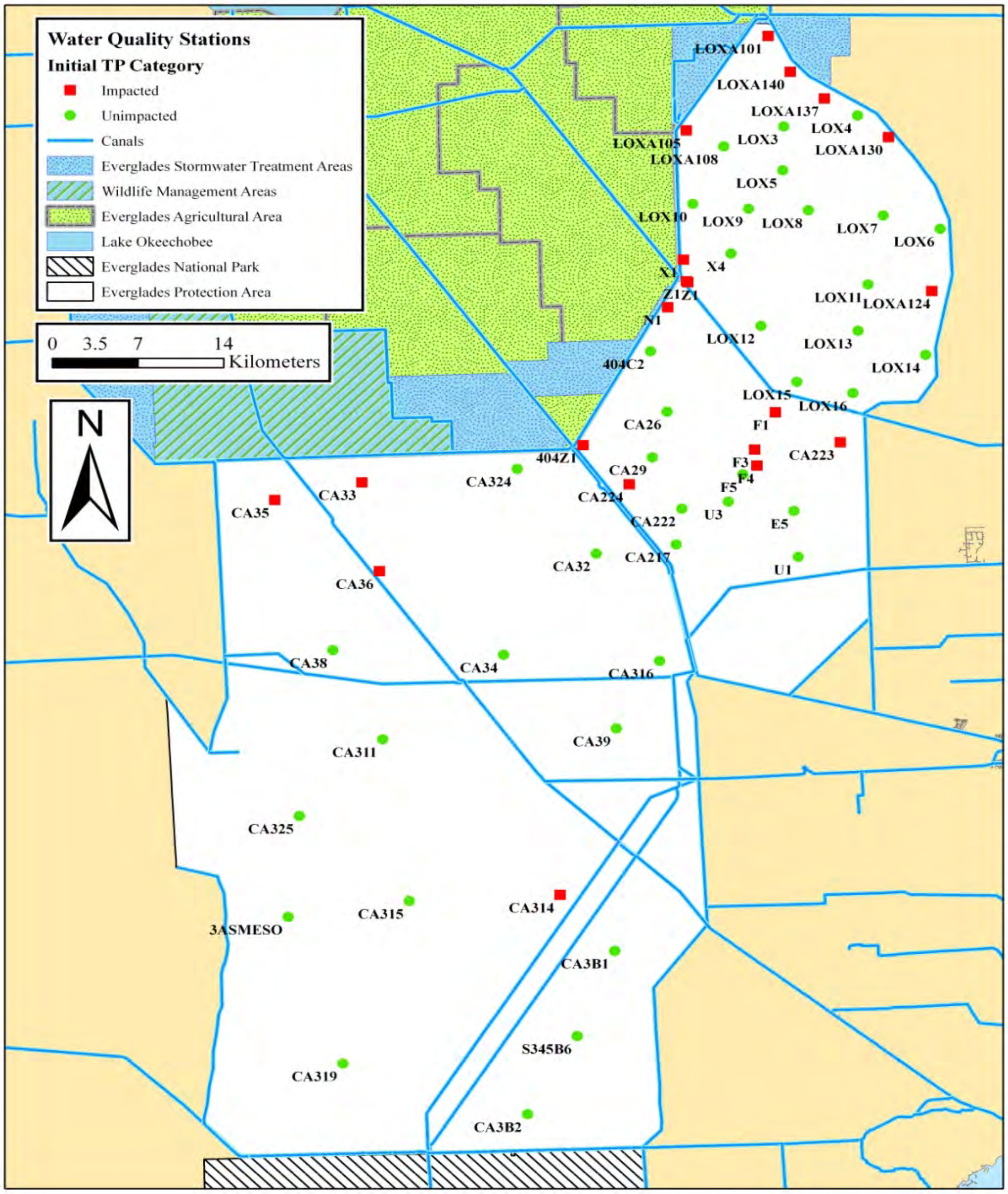


Figure F-8. Total phosphorus (TP) criterion assessment network stations within the Everglades Protection Area (EPA).

Note: All sites were used in the Water Years 2008–2012 (WY2008–WY2012; May 1, 2007–April 30, 2012) evaluation.

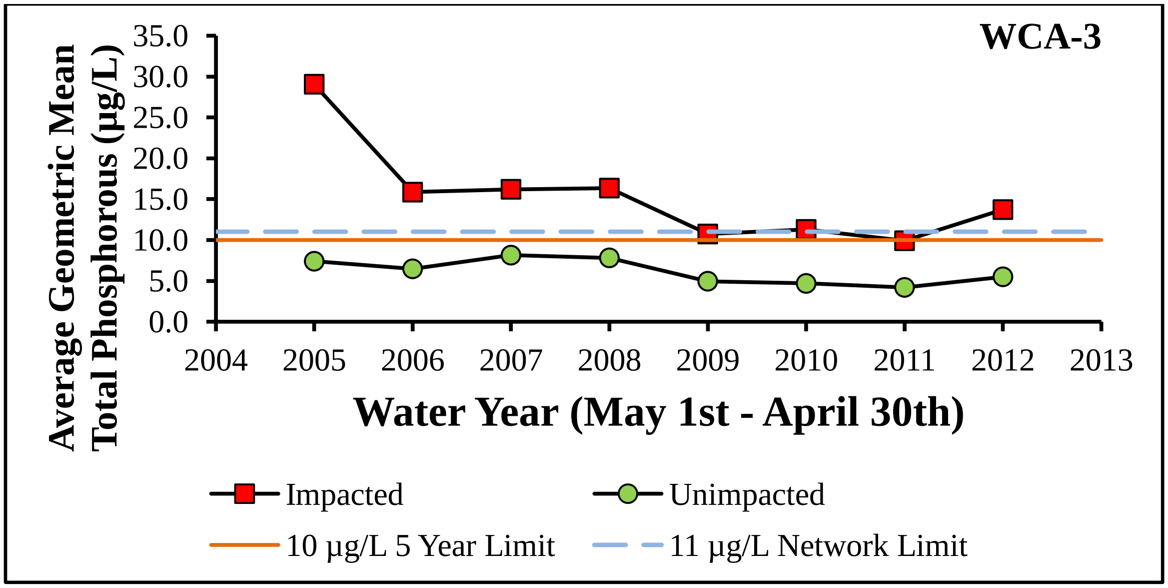


Figure F-9. Network (impacted and unimpacted) trends for WCA-3 from WY2005–WY2012 relative to the TP 10 µg/L long-term (five-year) and 11 µg/L network limits

[Note: Adapted from Julian, 2013.]

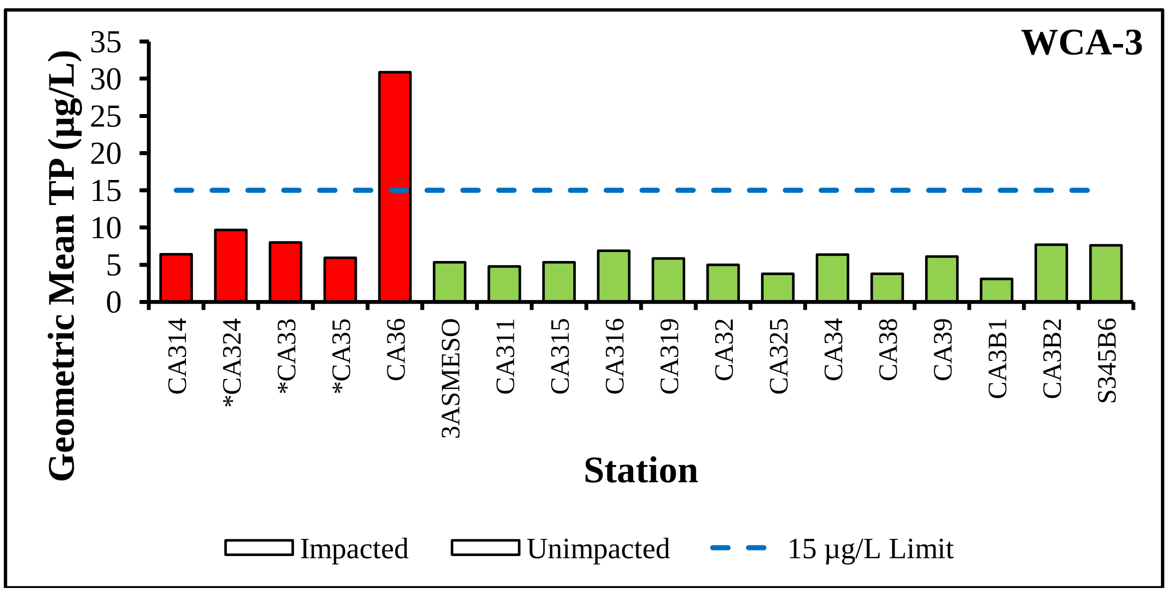


Figure F-10. TP geometric mean (µg/L) for each station during WY2012 for WCA-2 relative to the 15 µg/L annual limit.
[Note: Stations with less than six samples are identified with an asterisk (*) and not included in the compliance calculations; adapted from Julian, 2013.]

A trend analysis was performed using annual compliance TP data for TP Rule monitoring stations in WCA-3 for the period from Florida Water Years 2005 through 2012. The results of this trend analysis are presented in **Table F-5**, **Figure F-12,** and **Figure F-13**. The annual compliance TP data were taken from published South Florida Environmental Reports (SFWMD 2010, SFWMD

2011, SFWMD 2012 and SFWMD 2013). Two statistical tests were used to assess trends of these annual data sets for each monitoring station: 1) a linear regression (and Pearson Correlation); and 2) Spearman's Rank Correlation. A linear regression (parametric method) assumes that the residuals (i.e., regression errors) do not deviate significantly from a normal distribution. On the other hand, Spearman's Rank Correlation makes no assumption regarding the distribution of the residuals. Given the sparse quantity of data for each monitoring station ($n \leq 8$), it is highly improbable that the residuals from these regressions follow a normal distribution. **Table F-5** presents the results from both the parametric and non-parametric trend analyses for these monitoring stations. A graphic presentation of the annual compliance geometric mean TP data for impacted and unimpacted marsh monitoring stations is presented in **Figure F-11**, **Figure F-12A** and **Figure F-12B**. Due to data density and screening protocol requirements for the TP Rule, some water years and one marsh station (CA324) were removed from the trend analyses.

Of the 17 monitoring stations analyzed, 16 stations exhibited a decreasing trend based on linear regression results (**Table F-5**) with six of these stations exhibiting a statistically significant decrease in annual TP concentrations. One marsh station (3ASMESO) exhibited a slight increasing trend that was not statistically significant (p-value = 0.933; **Table F-5**).The results from the Spearman's Rank correlation indicate that all 17 stations exhibited a decreasing trend in annual geometric mean TP concentrations with 10 marsh stations having statistically significant decreases in annual geometric mean TP concentrations (**Table F-5**). Most marsh stations exhibited a slight increase (up to 2 µg/L) in annual geometric mean TP concentration during Florida Water Year 2012. However, three marsh stations (CA36, CA3B2 and S-345B6) exhibited a 4 to 10 µg/L increase in annual geometric mean TP during the last water year. Future changes in historic TP concentrations will likely be more noticeable for marsh stations located adjacent to the major project features such as the Miami Canal backfill, the L-4 levee degrade/spreader, WCA-3B inflows and the Blue Shanty Flow-way. A review of the long-term phosphorus data presented in the 2013 South Florida Environmental Report (SFWMD, 2012) suggests the likelihood of more marsh stations and some of the inflow/outflow structures exhibiting significant decreasing trends if a seasonal Kendall trend analysis were to be performed using monthly TP data over a period longer than the Florida Water Year 2005 to 2012 period presented herein.

Construction of the Miami Canal Backfill component of the CEPP is expected to re-mobilize sediment containing elevated concentrations of TP while construction is being conducted. Depending upon the proximity of the backfill construction to marsh stations, it is possible that the annual geometric mean TP concentrations could exceed or contribute to exceedances of portions of the four part test. With regard to backfilling and re-vegetation, once these activities are complete, marsh stations in the vicinity of the backfill, such as CA36, are likely to experience TP concentrations lower than those historically observed. Once operations commence, stations influenced by the re-introduction of water in northwestern WCA-3A may observe perturbations until such time as fewer dry-outs and stable conditions are established.

The L-4 levee degrade and spreader canal in northwest WCA-3A are likely to impact marsh stations during construction and post construction. Depending upon the proximity of the spreader canal construction to marsh stations, it is possible that the annual geometric mean TP concentrations could exceed or contribute to exceedances of portions of the four part test during construction. Post-construction (i.e., operations), the L-4 Spreader Canal in northern WCA-3A could influence TP Rule compliance since water management activities are expected to have a far reaching effect. While the water discharged to the L-4 Spreader Canal is expected to achieve the WQBEL, the reintroduction of water and alteration of hydroperiods is expected to cause temporary phosphorus reflux in the impacted areas and therefore facilitate temporary mobility of phosphorus in portions of the system. It is expected that the system will stabilize after some period of time and that the mobilization of phosphorus from the impacted areas will be reduced substantially; however, in the interim, it is expected that the mobilized phosphorus will travel within portions of WCA-3 until more stable conditions are established.

Construction of the Blue Shanty levee from L-67C to Tamiami Trail will convert the southwestern corner of WCA-3B into a flow-way. The S-632 and S-633 structures constructed in the L-67A levee will allow L-67A canal flows to be diverted into the Blue Shanty Flow-way before reaching the northern boundary of ENP. Marsh TP concentrations in the northern portion of this flow-way will likely increase. The CEPP Water Quality Monitoring Plan calls for the future establishment of a marsh monitoring station located within the Blue Shanty Flow-way. The geometric mean TP concentration at the S-333 was used to estimate the range of existing annual TP concentrations at the new Blue Shanty marsh monitoring station. From WY2008 – WY2012 the annual geometric mean TP concentration at S-333 varied from 10-16 ppb.

Table F-4. Annual TP criteria compliance assessment for the five-year period from WY2008–WY20012.

Network	WY	Station	Sample Size (N)	Annual Site Geometric Mean (µg/L)	≤15 µg/L Pass/ Fail	Network Annual Average Geometric Mean (µg/L)	≤11 µg/L Pass/ Fail	Network Five-Year Average Geometric Mean (µg/L)	≤10 µg/L Pass/ Fail
		CA314	11	7.3	Pass				
		CA324	1	N/A (14)	N/A				
	2008	CA33	7	14.4	Pass	**16.4**	Fail		
		CA35	6	8	Pass				
		CA36	6	35.7	Fail				
		CA314	12	4.3	Pass				
		CA324	6	11.1	Pass				
	2009	CA33	14	8.4	Pass	**10.76**	*Pass*		
		CA35	11	6.9	Pass				
		CA36	15	23.1	Fail				
		CA314	12	4.5	Pass				
		CA324	5	N/A (12.5)	N/A				
	2010	CA33	8	8.8	Pass	12.3	Fail		
		CA35	5	N/A (7.1)	N/A				
		CA36	8	23.6	Fail				
		CA314	10	4	Pass				
		CA324	4	N/A (10.4)	N/A				
	2011	CA33	7	7.5	Pass	9.8	*Pass*		
		CA35	6	5.6	Pass				
		CA36	9	22	Fail				
		CA314	10	6.4	Pass				
		CA324	5	N/A (9.7)	N/A				
	2012	CA33	5	N/A (8)	N/A	**18.7**	Fail		
		CA35	3d	N/A (5.9)	N/A				
Impacted		CA36	6	30.9	Fail				

Network	WY	Station	Sample Size (N)	Annual Site Geometric Mean (µg/L)	≤15 µg/L Pass/ Fail	Network Annual Average Geometric Mean (µg/L)	≤11 µg/L Pass/ Fail	Network Five-Year Average Geometric Mean (µg/L)	≤10 µg/L Pass/ Fail
	2008 - 2012	**Five-Year Network Average**						**12.9**	Fail
		3 of 5 Year Network Average ≤ 10 µg/L				Fail			
Unimpacted	2008	3ASMESO	16	7.3	Pass	**7.8**	*Pass*		
		CA311	21	6.9	Pass				
		CA315	22	7.9	Pass				
		CA316	19	10.8	Pass				
		CA319	10	6.8	Pass				
		CA32	8	7.5	Pass				
		CA325	6	5.6	Pass				
		CA34	9	14.5	Pass				
		CA38	13	6.6	Pass				
		CA39	10	6.8	Pass				
		CA3B1	10	6	Pass				
		CA3B2	8	7.6	Pass				
		S-345B6	12	7.4	Pass				
	2009	3ASMESO	16	4.6	Pass	**5**	*Pass*		
		CA311	18	4.7	Pass				
		CA315	19	4.9	Pass				
		CA316	19	6.3	Pass				
		CA319	12	4.5	Pass				
		CA32	17	5.7	Pass				
		CA325	7	4.6	Pass				
		CA34	16	6.8	Pass				
		CA38	15	4.9	Pass				
		CA39	11	4.8	Pass				
		CA3B1	10	3.6	Pass				

Network	WY	Station	Sample Size (N)	Annual Site Geometric Mean (µg/L)	≤15 µg/L Pass/ Fail	Network Annual Average Geometric Mean (µg/L)	≤11 µg/L Pass/ Fail	Network Five-Year Average Geometric Mean (µg/L)	≤10 µg/L Pass/ Fail
		CA3B2	11	4.6	Pass				
		S-345B6	17	4.5	Pass				
	2010	3ASMESO	15	4.4	Pass	**4.7**	***Pass***		
		CA311	10	4	Pass				
		CA315	10	4.3	Pass				
		CA316	10	6.4	Pass				
		CA319	11	4.7	Pass				
		CA32	11	4.9	Pass				
		CA325	11	4.6	Pass				
		CA34	10	7	Pass				
		CA38	9	4.4	Pass				
		CA39	11	4.9	Pass				
		CA3B1	10	3.4	Pass				
		CA3B2	11	4.4	Pass				
		S-345B6	12	3.6	Pass				
	2011	3ASMESO	9	3.5	Pass	**4.2**	***Pass***		
		CA311	10	4.3	Pass				
		CA315	11	4.3	Pass				
		CA316	10	6	Pass				
		CA319	10	4.4	Pass				
		CA32	7	4.8	Pass				
		CA325	6	4.6	Pass				
		CA34	8	5.4	Pass				
		CA38	8	3.5	Pass				
		CA39	8	4.3	Pass				
		CA3B1	9	3.2	Pass				
		CA3B2	10	3.3	Pass				

Network	WY	Station	Sample Size (N)	Annual Site Geometric Mean (µg/L)	≤15 µg/L Pass/ Fail	Network Annual Average Geometric Mean (µg/L)	≤11 µg/L Pass/ Fail	Network Five-Year Average Geometric Mean (µg/L)	≤10 µg/L Pass/ Fail
		S-345B6	10	3	Pass				
	2012	3ASMESO	9	5.3	Pass	**5.5**	***Pass***		
		CA311	8	4.8	Pass				
		CA315	9	5.3	Pass				
		CA316	8	6.9	Pass				
		CA319	10	5.8	Pass				
		CA32	8	5	Pass				
		CA325	8	3.8	Pass				
		CA34	7	6.4	Pass				
		CA38	6	3.8	Pass				
		CA39	10	6.1	Pass				
		CA3B1	7	3.1	Pass				
		CA3B2	8	7.7	Pass				
		S-345B6	9	7.6	Pass				
	2011 - 2012	**Five-Year Network Average**						**5.4**	***Pass***
		3 of 5 Year Network Average ≤ 10 µg/L				***Pass***			

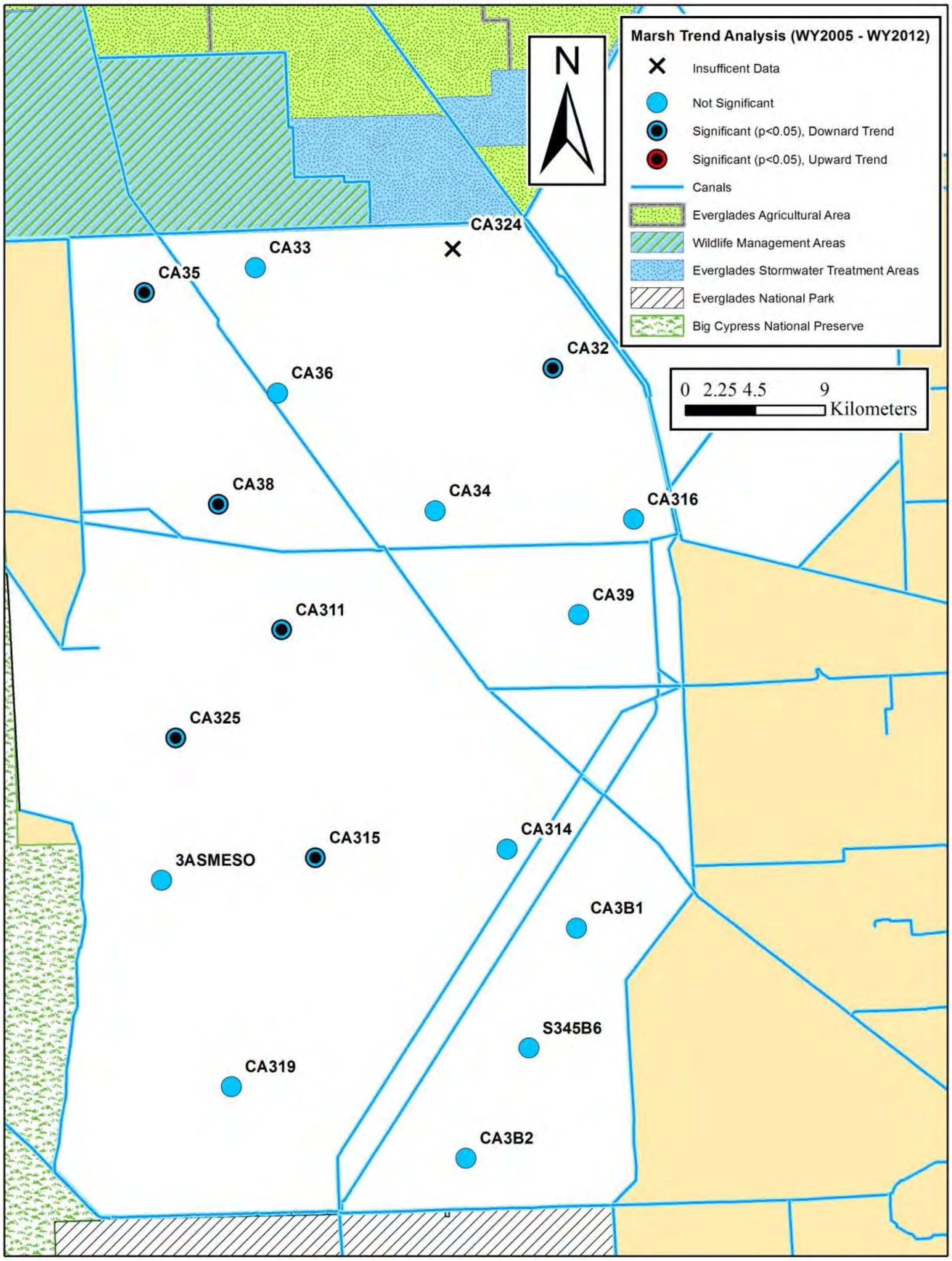


Figure F-11. Trend Analysis for Geometric mean TP concentrations at marsh monitoring stations.

Table F-5. Trend analysis of annual compliance geometric mean TP concentrations for impacted and unimpacted marsh stations in WCA-3 for the period from Florida Water Year 2005 through 2012.

Network	Station	No. Of Obs.	Linear Regression					Spearman's Rank Correlation		
			R^2	m	R_p	df	p-value	R_s	df	p-value
Impacted	CA314	5	0.05	-0.21	-0.23	4	0.713	-0.30	3	0.624
	CA324		*Insufficient Compliance Data to Perform Analysis (n = 1)*							
	CA33	6	0.61	-1.36	-0.78	5	0.066	-0.89	4	***0.019***
	CA35	4	0.91	-0.56	-0.95	`````	***0.046***	-1.00	2	***<0.001***
	CA36	6	0.15	-1.01	-0.39	5	0.444	-0.41	4	0.425
Unimpacted	3ASMESO	8	<0.01	0.02	0.04	7	0.933	0.17	6	0.693
	CA311	8	0.58	-0.44	-0.76	7	***0.028***	-0.76	6	***0.028***
	CA315	8	0.73	-0.62	-0.86	7	***0.007***	-0.75	6	***0.031***
	CA316	8	0.50	-0.60	-0.71	7	***0.049***	-0.74	6	***0.037***
	CA319	5	0.10	-0.21	-0.32	4	0.599	-0.30	3	0.624
	CA32	7	0.49	-0.55	-0.70	6	0.080	-0.79	5	***0.036***
	CA325	5	0.79	-0.36	-0.89	4	***0.042***	-0.89	3	***0.041***
	CA34	6	0.55	-1.21	-0.74	5	0.093	-0.83	4	***0.042***
	CA38	8	0.74	-0.41	-0.86	7	***0.006***	-0.76	6	***0.028***
	CA39	5	0.08	-0.19	-0.29	4	0.635	-0.30	3	0.624
	CA3B1	5	0.65	-0.62	-0.81	4	0.097	-1.00	3	***<0.001***
	CA3B2	5	0.01	-0.11	-0.09	4	0.890	<-0.01	3	1.000
	S345B6	8	0.26	-0.64	-0.51	7	0.192	-0.50	6	0.207

R^2 = Coefficient of Determination; R_P = Pearson Correlation Coefficient; R_S = Spearman' Rank Correlation Coefficient; df = Degrees of Freedom; m = Slope or Inclination of Regression; p-value = probability.

(Note: Trends were determined using a parametric (linear regression) and a non-parametric (Spearman's Rank Correlation) method. A significance level (α) of 0.05 was assumed. Bolded and italicized p-values identify trends that are statistically significant. Data used for these analyses were taken from South Florida Environmental Reports (SFWMD 2010, SFWMD 2011, SFWMD 2012 and SFWMD 2013)).

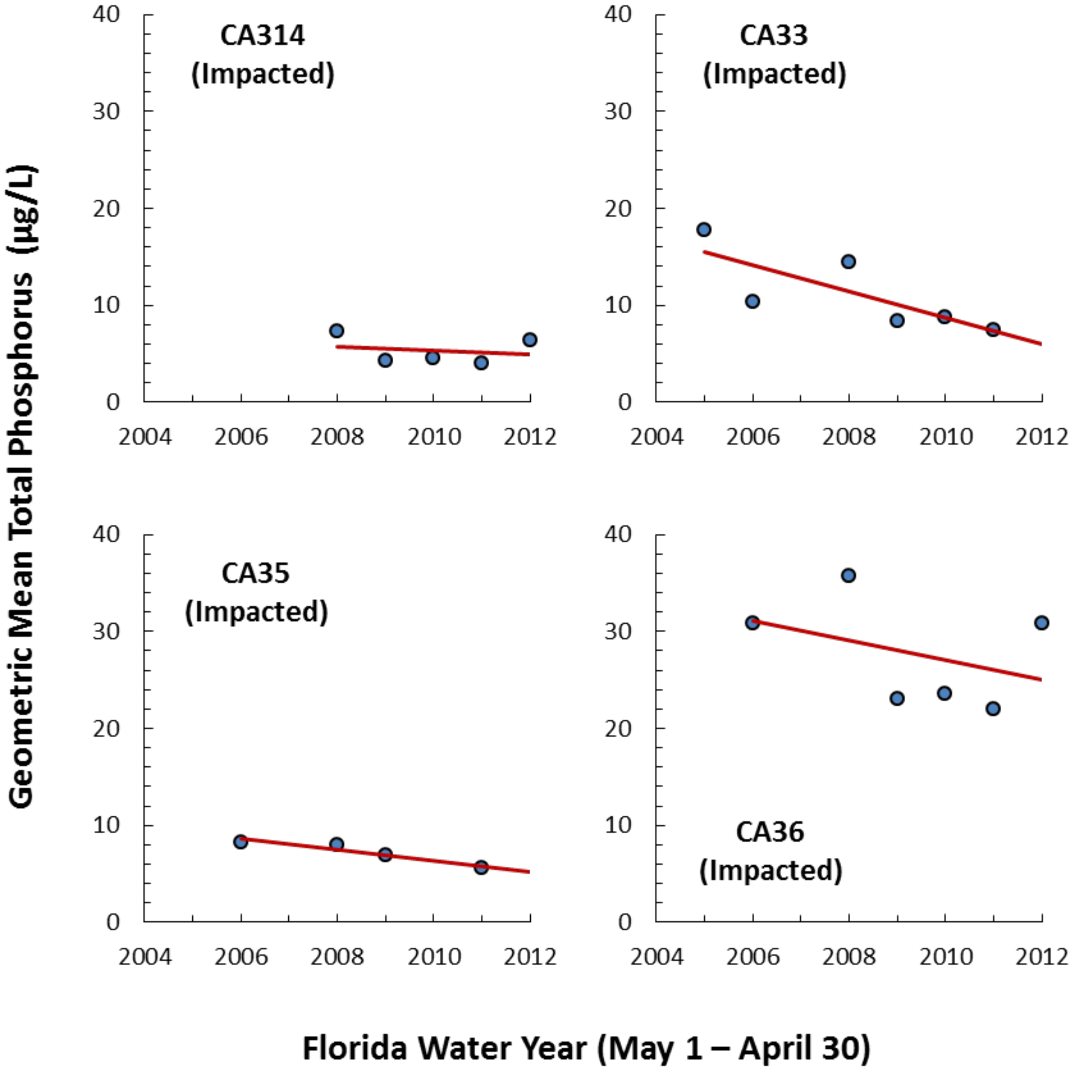


Figure F-12. Annual compliance geometric mean TP concentrations for each impacted marsh station in WCA-3 from Florida Water Years 2005 through 2012.

(Note: Statistics for the linear regression trend lines are summarized in Table F-5. Data used in this analysis were taken from the South Florida Environmental Reports (SFWMD 2010, SFWMD 2011, SFWMD 2012 and SFWMD 2013)).

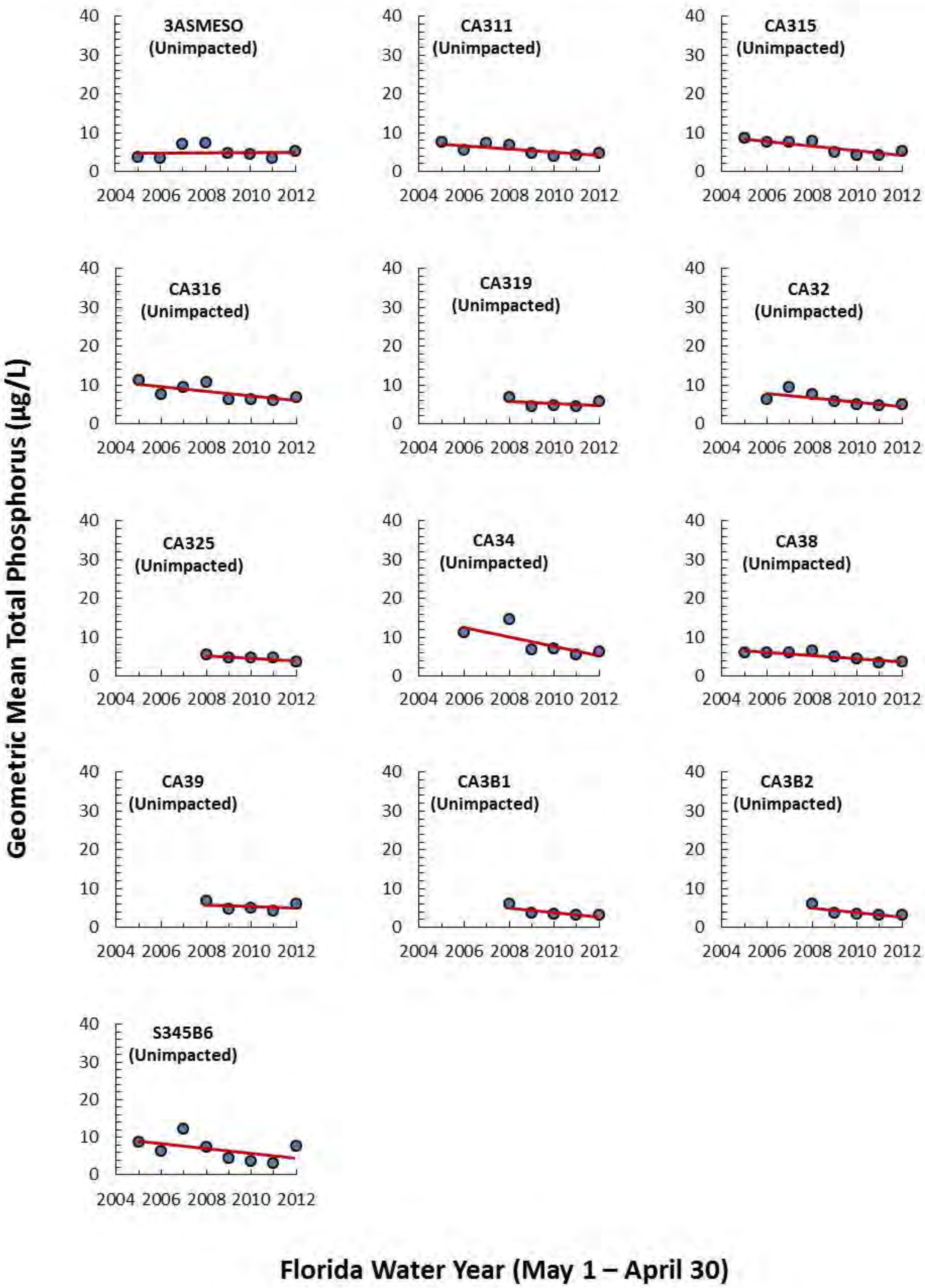


Figure F-13. Annual compliance geometric mean TP concentrations for each unimpacted marsh station in WCA-3 from Florida Water Years 2005 through 2012.

(Note: Statistics for the linear regression trend lines are summarized in Table F-5. Data used in this analysis were taken from the South Florida Environmental Reports (SFWMD 2010, SFWMD 2011, SFWMD 2012 and SFWMD 2013)).

F.4 WATER CONSERVATION AREA 3B (WCA-3B)

Water quality in WCA-3B will be affected by the construction of all the structures in the L-67A levee and the construction of the Blue Shanty Flow-way. The S-631 structure will deliver L-67A canal flows into WCA-3B and structures S-632 and S-633 will deliver water into the Blue Shanty Flow-way (**Figure F-7**). The inflow through these structures is affected by the water quality in the L-67A canal, which is influenced by discharges from the S-9 Pump Station. Channelized discharges from S-9 and S-9x pump stations tend to degrade water quality in the L-67A canal, which may impact water quality within WCA-3B and the Blue Shanty Flow-way.

The Blue Shanty Flow-way will result in hydraulic isolation of the southwest corner of WCA-3B from the eastern portion of this WCA. Nutrient uptake within the Blue Shanty Flow-way marsh will likely lower the concentration of TP in water delivered through this flow-way to ENP. **Table F-4** shows the annual and five-year geometric mean TP concentrations for the three TP Rule marsh stations in WCA-3B. Though the state calculates compliance with the TP rule for WCA-3 (3A & 3B) as a whole, these data show that all stations in WCA-3B currently meet the annual test provisions of the TP Rule. While operations under ALT4R are expected to improve hydroperiods within WCA 3B, the system is primarily rainfall driven. Changes in the operations of this area may or may not affect compliance with the annual tests provisions of the TP Rule for these stations until the system can adapt to the conditions imposed through the implementation of ALT4R2.

Impacts to marsh TP concentrations during construction of the S-631 structure are expected to be minimal given the distance between the feature and the marsh monitoring stations. Releasing L-67A canal flows through the S-631 structure is likely to cause the geometric mean TP concentration of the three WCA-3B marsh stations to increase somewhat. This is particularly true when considering the phased implementation of CEPP components. While uncertainty exists, it is unlikely that discharges into WCA-3B will cause or contribute to violations of the TP Rule, particularly the annual test provisions of the TP Rule. Over the long-term, the risk of exceedances of the TP Rule in WCA-3B and WCA-3A is expected to decrease as upstream concentrations adjust.

Structures S-355A and B are located along the L-29 levee and allow WCA-3B discharges to the L-29 borrow canal and ENP at Tamiami Trail. Under the previous limited test operations, which include limited structural inflows to WCA-3B, the structures can only discharge a small fraction of their design capacity of 1,000 cubic feet per second (cfs) each. Water quality data has been collected at the S-355 A and B structure locations (**Table F-6**). The TP concentrations at these structures are elevated; however, the adjacent marsh concentrations are low. The average annual (Federal Water Year Oct-1 to Sep-30) concentration at the structures varies between approximately 10 and 39 ppb while the adjacent marsh concentrations are typically lower than 10 ppb. The elevated levels at the structures are likely associated with the stagnant, non-flowing conditions and legacy phosphorous that has accumulated in the collection canals. The structures have been operated only a few times. Water quality data collected during operational tests indicated that the TP concentrations typically drop during discharge events. From the limited data collected, the discharge concentrations were in the 7 to 19 ppb range during discharge events. The CEPP Adaptive Management Plan is proposing to dredge out old agricultural canals that are located in southern WCA-3B to help improve the discharge efficiencies of these structures. If this dredging is done it will need additional NEPA analysis and water quality assessments.

Table F-6. Annual Arithmetic average TP concentrations (µg/L) of grab samples at structures at Shark River Slough (SRS) near WCA-3B.

Water Year	S-331/S173	S-334/S-356	S-355A*	S-355B*	S-333
2008	8.2	10.6	22.8	32.9	11.7
2009	8.1	12.0	15.3	19.0	13.0
2010	7.4	9.8	9.6	14.3	11.3
2011	11.4	17.1	25.2	38.7	19.7
2012	7.5	10.2	16.1	16.9	10.5

All averages based on federal water year (Oct-1 to Sep 30)

* These structures are mostly closed so the concentrations are not indicative of water quality in the nearby marsh.

F.5 EVERGLADES NATIONAL PARK (ENP)

Compliance with TP water quality criteria for water entering ENP is specified in Chapter 62-302.540, F.A.C. The rule states that "Achievement of the phosphorus criterion in the Park shall be based on the methods as set forth in Appendix A of the Settlement Agreement unless the Settlement Agreement is rescinded or terminated….. the Department shall review data from inflows into the Park at locations established pursuant to Appendix A of the Settlement Agreement and shall determine that compliance is achieved if the Department concludes that phosphorus concentration limits for inflows into the Park do not result in a exceedance of the limits established in Appendix A."

Construction of ALT4R2 project features such as the Blue Shanty Flow-way, L-29 levee degrade, L-67 Extension canal backfilling, and flow capacity increases at the S-333 and S-356 structures will alter the quality, quantity, timing, and distribution of flows entering SRS in northern ENP. Non-CEPP features, such as the Tamiami Trail 1-one mile bridge that is under construction, and the future Tamiami Trail Next Steps Bridge Project will also alter flow patterns into SRS.

F.5.1 Impact of CEPP on Future Loads into ENP

The CEPP will impact how water is delivered from WCA-3 to the Park. ALT4R includes backfilling the Miami Canal and increasing sheetflow through the marsh area. Backfilling alone will decrease the direct transport of legacy TP to SRS. The improved sheetflow will result in WCA-3A outflow water quality being more influenced by marsh background water quality. ALT4R assumes that marsh uptake of TP occurs in northern WCA-3A. This will likely reduce TP concentrations in southern WCA-3A. After the system stabilizes or responds consistently with lower concentrations as a result of restored hydroperiods, concentrations are expected to be lower than the ECB condition and lower than the FWO condition. Increased TP uptake should improve SRS FWM TP concentrations relative to ECB and FWO.

F.5.2 New Tamiami Trail Inflow Locations

ALT4R2 includes several modifications along and southeast of Tamiami Trail which is the northern boundary of ENP. These modifications include increased capacity at the S-333 and S-356 structures, degrade of the L-29 Levee at the southern boundary of the Blue Shanty Flow-way, backfilling of the L-67A Canal Extension, removal of the temporary S-356 structure and Old Tamiami Trail, operation of the S-355 A and B structures, and installation of a seepage cutoff wall along the L-31 N Levee south and north of Tamiami Trail. In addition to the CEPP-related project features, the U.S. Department of the

Interior's "Tamiami Trail – Next Steps" project will also affect flows across Tamiami Trail into SRS. Existing annual average TP concentrations for existing structures near SRS is provided in **Table F-6**. A short discussion of anticipated changes to TP flows and loads as a result of each of these features is included below.

F.5.2.1 S-333 Structure

The capacity of the S-333 structure will be increased from 1,350 cfs to 2,500 cfs under ALT4R2. **Table F-7** shows that with ALT4R which is similar to ALT4R2, the percentage of the total SRS flows that pass through the S-333 structure will increase from around 17 to 55 percent, while the S-12x structures will pass a substantially decreased fraction of these flows during the calendar year. At present the average TP concentrations at S-333 are greater than those at the S-12x structures because S-333 flows are dominated by canal contributions and the western most S-12x structure flows are dominated by marsh contributions. Future flow to SRS via the L-67A canal is expected to consist of water that has passed through the marsh due to backfilling of the Miami Canal in northern WCA-3A. TP concentrations in CEPP sheetflow could potentially be reduced to historical marsh levels. However, there still exists a potential for an exceedance due to the increased volume over the FWO condition. Prior to and during the project implementation period, TP concentrations may remain somewhat elevated relative to background concentrations due to the transport of legacy TP from impacted areas, re-suspension of canal sediments, and S9x flows and loads delivered prior to full implementation of CEPP and other CERP related projects. Prior to increasing the S-333 capacity, a detailed evaluation as part of the permitting process will be done to ensure that the increased discharge will not impose a problem in terms of water quality compliance for the Park.

Table F-7. Distribution of average flows (ac-ft/(calendar year) through S-333 and S-12A, S-12B, S-12C, and S-12D for ECB, FWO, and ALT4R.

Alternative	Annual Average Discharge Through S-12x and S-333 Structures					
	S-12A	**S-12B**	**S-12C**	**S-12D**	**S-333**	**Total**
ECB	37,328	98,566	172,917	384,881	129,721	823,413
Percent of total	5%	12%	21%	47%	16%	100%
FWO	29,757	92,160	242,851	320,396	137,152	822,317
Percent of total	4%	11%	30%	39%	17%	100%
ALT4R	15,867	48,264	152,743	206,291	522,956	946,122
Percent of total	2%	5%	16%	22%	55%	100%

F.5.2.2 Degradation of the L-29 Levee South of the Blue Shanty Flow-way

ALT4R2 includes degrading the L-29 levee in the stretch between the S-333 structure and the levee that defines the eastern edge of the Blue Shanty Flow-way. Water will enter the Blue Shanty Flow-way through the S-632 and S-633 structures located on the southern end of the L-67A canal. Uptake of TP is expected to occur as this water passes through the flow-way marsh and arrives at the degraded L-29 levee. The water that passes through the flow-way is expected to have lower TP concentrations. The dominant direction of this flow will be north to south. However, there are likely to be periods when the flow pattern is reversed. The 2005-2012 average TP concentrations at SRS marsh monitoring stations, P33, NE1, and NP201 presented in **Table F-8** below. The TP concentrations at these SRS marsh stations are expected to remain at or below existing background levels given the distribution of flows across the length of the degraded levee. However, we may see a slight increase in TP during times when there is increase in total loads and flow. Some SRS marsh stations have been isolated from surface water loading for decades. When more natural overland flow is established with CEPP, there is uncertainty as to how loading and water movement will affect how total phosphorous concentrations in the marsh respond.

Table F-8. WY2005–WY2012 average TP concentrations observed at SRS monitoring stations.

Water Year (Oct-1 to Sep 30)	NE1	NP201	P33	P34	Overall
2005	5.2	10	9.2	3.9	6.9
2006	5.4	7.0	8.4	4.5	6.2
2007	6.4	5.5	7.2	4.3	5.8
2008	6.7	6.1	7.2	4.8	6.2
2009	5.8	3.6	5.8	3.6	4.7
2010	4.5	3.6	6.1	4.9	4.7
2011	3.8	3.8	6.2	5.3	4.6
2012	5.2	5.6	5.4	4.1	5.1

F.5.2.3 L-67A Extension Backfill and Levee Degrade

The L-67A Extension canal connects to the L-29 borrow canal just east of the S-333 structure. Removal of the L-67A Extension levee and canal and the Old Tamiami Trail are included in ALT4R2 because it will allow for sheetflow distribution as flows travels south into SRS. Construction activity during backfilling and degrading of the L-67A Extension and the Old Tamiami Trail may result in the temporary mobilization of legacy phosphorus contained in canal sediments. Impacts from the mobilization of TP during construction may temporarily increase the geometric mean TP concentrations at the ENP NP201 marsh monitoring stations. After the removal of the L-67 Extension and the Old Tamiami Trail are completed, the additional flow dispersion in northern SRS will reduce the likelihood that marsh concentrations within this area are adversely impacted by CEPP flows.

F.5.2.4 Increased Flow Capacity at S-356

The S-356 pump station is intended to return seepage collected in the L-30 and L-31N canals back to the L-29 canal so that it can flow south into northeast SRS. As part of ALT4R2, the capacity of this pump will be increased from 500 cfs to 1,000 cfs in order to capture the additional seepage that results from higher water levels in WCA-3B. There is a sampling station at S-334 and S-356, which is located adjacent to the intake of the S-356 pump station. Data collected at this structure indicates that average TP concentrations varied between 9.7 and 17.1 µg/L for WY2008 through WY2012; however, since the S-356 pump station has not been operated, these values are indicative of S-334 flows and not very useful for estimating future S-356 water quality under CEPP conditions. Further south are the S-331 pump station and the S-173 culvert that also draw water from the L-31N canal. Future water quality at the S-356 structure will reflect a mix of seepage water from the west (WCA-3B, ENP) and L-31N basin runoff from the east. At present, no prediction model is available to assess future quality at the S-356 pump station; however, historic water quality at the S-331/S173 provides the best available indication of future S-356 water quality with CEPP. From **Table F-6**, for the WY2008–WY2012 period the S-331/S173 annual average TP concentrations varied between 7.4 and 11.4 µg/L.

F.5.2.5 Seepage Cutoff Wall in L-31N Levee

ALT4R2 includes a seepage cutoff wall constructed in the northern reach of L-31N levee north of the G-211 structure. This seepage cutoff wall will hydraulically isolate the upper portion of the surficial Biscayne Aquifer from the L-31N canal and presumably reduce seepage losses from northeastern ENP eastward compared to what would be experienced without a seepage wall in the presence of higher Everglades stages. Since TP concentrations in northern L-31N canal reflect a mixture of sources such as ENP seepage, L-31N basin runoff, and C-4 releases, a change in seepage conditions or operations will impact L-31N TP concentrations. The Regional Simulation Model - Glades LECSA (RSMGL) model results show an increase in seepage from an average of 90 to 150 kac-ft/yr, in the northern reach of L-31N canal. It follows that relative to ECB and FWO conditions, the cutoff wall will not eliminate or reduce ENP seepage that flows eastward. Since the cleaner seepage flows will represent a greater portion of total reach flow under ALT4R2, the average TP concentrations in the northern portion of L-31N canal should improve during times where we see increased seepage.

F.5.2.6 Tamiami Trail Bridge Projects

The Modified Waters Delivery Project 1-mile long Tamiami Trail bridge is nearing completion in summer 2013. This bridge is located just west of the S-334 and S-356 structures along U.S. Highway 40 (Tamiami Trail) and will allow flows from the L-29 canal flowing underneath the Bridge into the Park, once the old roadway is removed. The U.S. Department of the Interior has initiated design, planning and authorization for the Tamiami Trail Next Steps Bridge Project. This project includes a 2.65-mile long bridge(s) that will be located just downstream of the Blue Shanty Flow-way. Similar to the MWD 1-mile long Tamiami Trail Bridge, it will improve the distribution of inflows entering northeast SRS from a series of culverts to a widely distributed sheetflow delivery. The 2.65-mile bridge will allow water from WCA-3A, S-333, the Blue Shanty Flow-way, and L-29 canal to enter northeast SRS. Under ALT4R2, the water flowing under these new bridges is expected to reflect decreased TP concentrations from improved marsh hydrological (e.g., sheetflow distribution) and biological (e.g., uptake) processes in WCA-3A and Blue Shanty Flow-way, redistribution of lower-concentration S12x flows to the east (as indicated in **Table F-7**), increased contribution of lower-concentration seepage return flow to L-29 from S-356, and the addition of low-concentration water from WCA-3B via S-355-A/B, which should reduce concentrations relative to those currently observed at the S-333.

F.5.3 Appendix A Compliance at Shark River Slough

The implementation of the CEPP as well as other projects and operational schemes will alter the flow and locations at which these flows enter SRS. These changes will have an impact on SRS compliance with the requirements of state law and Appendix A from the 1991 Settlement Agreement. For CEPP, the three most important aspects of Appendix A compliance assessment are as follows: (1) CEPP-related increases in flow will reduce the Long Term Limit (LTL) for TP; (2) although long-term TP concentrations entering northeast SRS are expected to decrease, there will likely be short-term impacts of CEPP-related project implementation sequence on TP concentrations and loads; and (3) CEPP-related structural changes will alter existing SRS inflow points. All of these will have some effect on Appendix A compliance or the sufficiency of the compliance methodology and are currently undergoing review by a subteam assigned by the Everglades Technical Oversight Committee.

F.5.3.1 Impact of Additional CEPP Flows on SRS Compliance Limit

Appendix A compliance is currently assessed by comparing the Long Term Limit (LTL) against the 12-month flow-weighted mean (FWM) TP concentration in parts-per-billion, calculated using the measured flows from the S12A, S12B, S12C, S12D, and S333 structures that distribute flows from WCA 3A into SRS. The LTL, as defined in Appendix A of the 1991 Settlement Agreement, has an inverse relationship with flow; as flow into SRS increases, the LTL is reduced. Data from **Table F-9** shows that while the LTL concentration decreases as flow increases, the measured FWM concentration (1991-2011) has a similar historical trend of decreasing as flow increases. In addition, under ALT4R2, concentrations are expected to decrease from historical levels. Nonetheless, given that the measured FWM TP concentration at SRS has been very close or equal to the LTL since 2007 (shown in **Figure F-14** and **Table F-9)**, there is concern that the addition of CEPP flows could alter the frequency of compliance with the limit. Proposed CEPP annual flows are greater with ALT4R than for the ECB and FWO as shown in **Figure F-15**. Based on the current Appendix A compliance methodology, this increased flow volume results in a decrease of the LTL by about 2.0 ppb 50% of the time and by 1.0 ppb TP about 10% of the time, depending upon the annual inflow. ALT4R2 has a similar increase in flow at SRS. Furthermore, using the current Appendix A compliance methodology with CEPP, the minimum LTL compliance concentration of 7.6 ppb will be applicable about 20% more frequently. It is possible that exceedances of the LTL would occur due to the increased flow volume; however, the additional CEPP flow will be treated to the WQBEL and then be routed through the northern WCA-3A marsh which should lower TP concentrations relative to present conditions.

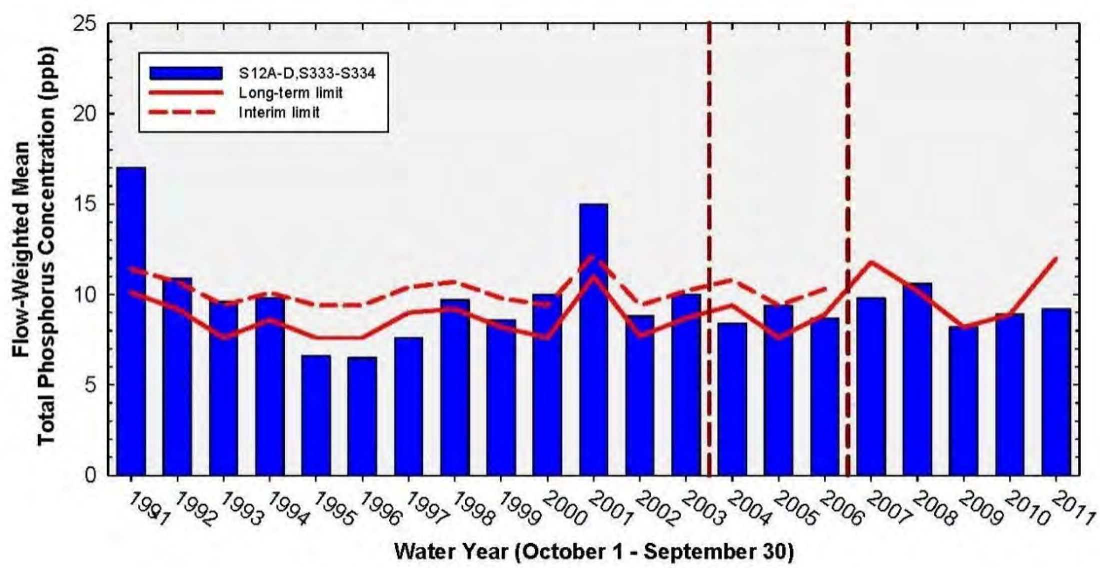


Figure F-14. SRS compliance history (from Settlement Agreement Report, SFWMD, 2011).

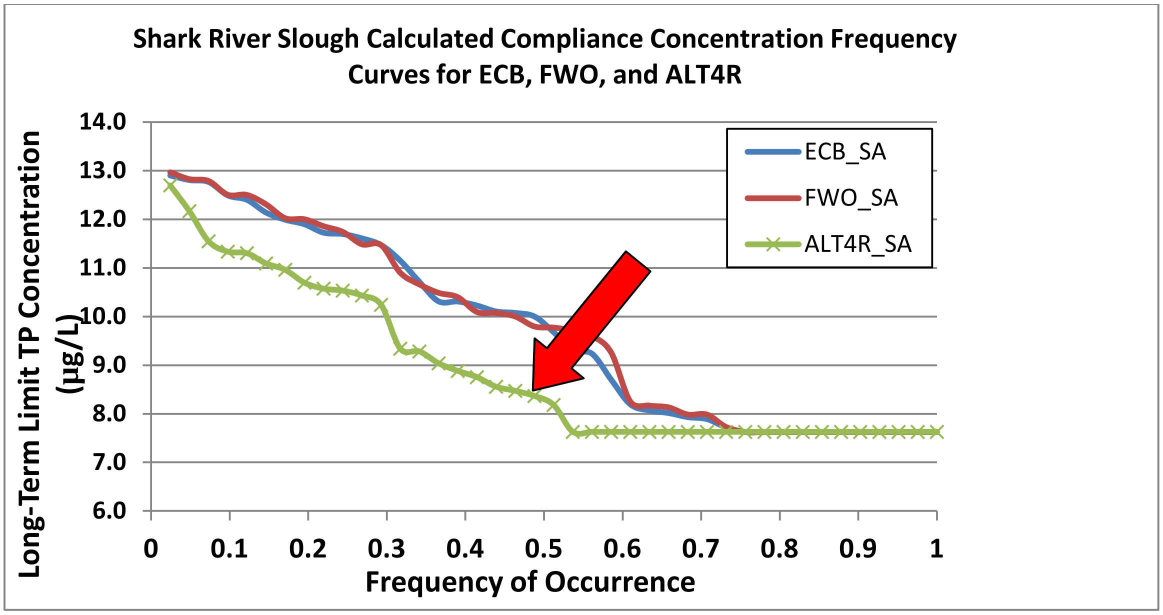


Figure F-15. Impact of increased CEPP flows on compliance criteria.

[Note: Arrow shows effect of increased flows on calculated long-term limit value, which is compared to measured FWM TP concentrations annually to determine compliance.]

Table F-9. SRS compliance history (data from quarterly Settlement Agreement Reports prepared by the SFWMD)

Water Year (Oct 1 to Sep 30)	Total Flow (S-12s+S-333) (kac-ft)	Interim Limit (µg/L)	Long-Term Limit[1] (µg/L)	Flow-Weighted Mean (S-12s+S-333-S-334) (µg/L)
WY1991	581.1	11.4	10.1	17.0
WY1992	738.7	10.7	9.2	10.9
WY1993	1529.6	9.4	7.6	9.6
WY1994	856.1	10.1	8.6	9.8
WY1995	2491.9	9.4	7.6	6.6
WY1996	1478.5	9.4	7.6	6.5
WY1997	786.5	10.4	9.0	7.6
WY1998	737.6	10.7	9.2	9.7
WY1999	939.8	9.8	8.2	8.6
WY2000	1145.3	9.4	7.6	10.0
WY2001	420.5	12.2	11.0	15.0
WY2002	1048.1	9.4	7.7	8.8
WY2003	850.1	10.2	8.7	10.0
WY2004	704.4	10.8	9.4	8.4
WY2005	1345.9	9.4	7.6	9.4
WY2006	814.1	10.3	8.8	8.7
WY2007	289.7	n/a	11.8	9.8
WY2008	562.0	n/a	10.2	10.6
WY2009	945.3	n/a	8.2	8.2
WY2010	809.9	n/a	8.9	8.9
WY2011	247.0	n/a	12.0	9.2

[1]LTL was effective in WY2007. LTL reported prior to WY2007 (shown in gray) are for reference only.

F.5.3.2 Effect of the Implementation Sequence on SRS TP Concentrations and Loads

In development of construction and sequencing implementation plan, a number of non-CEPP projects must be in place before implementing any CEPP features. These non-CEPP project features include Restoration Strategies and the Broward County Water Preserve Area C-11 Impoundment among others (see Section 6.0 Table 6-6 – Project Dependencies) and must be integrated into the sequencing of CEPP to avoid unintended adverse water quality consequences. Several basic principles were considered in development of an implementation plan for CEPP features which include the following:

1. All features of the State's Restoration Strategies must be completed and meet state water quality standards prior to initiating construction of most CEPP project features;
2. Construction of CEPP Project features cannot proceed until it is determined that construction and operation of the feature:
   a. Will not cause or contribute to a violation of State water quality standards; and
   b. Will not cause or contribute to a violation of any applicable water quality permit discharge limits or specific permit conditions ; and
   c. Reasonable assurances exist that demonstrate adverse impacts on flora and fauna in the area influenced by the Project features will not occur.

3. Appendix A water quality compliance must be addressed for new Project water entering Everglades National Park
4. Additional CEPP water quality treatment features, including operational and structural modifications, may need to be constructed if State water quality standards are not met upon operation of CEPP project features
5. Sequencing for the earliest opportunity to realize benefits, including the features that can provide benefits that utilize existing water meeting State water quality standards.

The most recent project implementation plan for ALT4R2 calls for a construction period of 15 to 20 years post-authorization. The proposed construction and sequencing implementation plan sequencing of the various project features in CEPP can have a substantial effect on the projects ability to comply with water quality standards. The construction and sequencing implementation plan is presented in **Table 6-6** in **Section 6.7.2** and was developed to maximize benefits while considering important constraints such as water quality (see **Section 2.0** of this document) and flood protection.

F.5.3.3 Effect of Altered Inflows and New Inflows on Appendix A Compliance Determination

At present, the quantification of flows and loads for Appendix A compliance includes measurement of point source flows and TP concentration at the S-12A-D, S-333, and S-334 structures. Appendix A calculations have included flows through the Tamiami Trail culverts, S-355A and S-355B structures though the flows are limited because either the structures are kept closed or the quantity is hydraulically limited. ALT4R2 includes new features such as the Blue Shanty Flow-way that will affect the location of inflows to SRS at Tamiami Trail. Also, increased marsh stages and altered flow patterns with ALT4R2 will increase flows through the Tamiami Trail culverts and the S-355A, S-355B, and S-356 structures. In addition to the CEPP changes to hydrology, the Tamiami Trail Bridge projects will provide new SRS inflows through sheetflow under these bridges.

It is uncertain how changes in flow distributions proposed under CEPP will impact compliance with Appendix A of the 1991 Settlement Agreement. Over the long-term, distributing the flow over the northern WCA-3A marsh, reducing short-circuiting down the canals to ENP, adding more flow from the lake that is treated to the WQBEL, and distributing these flows over the marsh should result in improvements by lowering the flow weighted mean total phosphorous concentration entering the Park. In the short-term, to address the uncertainty in compliance with Appendix A, the Technical Oversight Committee (TOC) is reviewing applicability of the current Appendix A compliance methodology for a restored ecosystem.

F.6 CONCLUSION

This paper provides evidence that implementation of ALT4R2 is likely to improve water column TP concentrations within most areas of WCA-3 primarily due to the use of state owned water quality treatment facilities and increased upstream storage capacity provided by the A-2 FEB along with backfilling of the Miami Canal and redistributing flows into the northwestern corner of WCA-3A, which should allow for uptake of TP within this marsh. Over the long-term it is likely that the project will beneficially affect WCA-3. However, there may be temporally and spatially limited impacts to TP concentrations within the marsh until more stabilized conditions are established. It is uncertain how changes in flow distributions proposed under CEPP will impact compliance with Appendix A of the 1991 Settlement Agreement.

It is important to note that this paper only includes a qualitative rather than quantitative assessment of Appendix A compliance at SRS. The impact of the project to Settlement Agreement compliance will be uncertain because the analysis is qualitative. A quantitative prediction of future SRS TP concentrations was not done because the uncertainties were considered to be unacceptably high. The limitation of predictive tools, uncertainties in the systems response and the lack of historic data that reflects the substantially altered flow and loading patterns contribute to these uncertainties. Also, with future Appendix A compliance methodology currently under review by the TOC, these quantitative predictions may be premature at this time.

Notwithstanding the inability to confidently predict future SRS inflow concentrations, SRS TP concentrations are expected to improve relative to ECB conditions and are likely to improve under ALT4R2 conditions. ALT4R is expected to improve marsh hydroperiods over FWO conditions, which will reduce the risk of downstream TP spikes caused by dry-out and rewetting. Additional TP uptake is also expected from ALT4R2 features such as Miami Canal Backfill and Blue Shanty Flow-way.

CEPP project features cannot proceed unless/until it is determined through the CERPRA permitting process that construction and/or operation of the feature 1) will not cause or contribute to a violation of water quality standards; 2) will not cause or contribute to a violation of the permit(s) discharge limits or specific conditions; and, 3) reasonable assurances exist that demonstrate adverse impacts on flora and fauna in the area influenced by the project element will not occur. Therefore, increased flows and TP loads associated with ALT4R implementation may be delayed until after the WQBEL is met for existing flows. The tentative feature implementation sequence for ALT4R2 is designed to minimize the potential for temporary increases in TP during project construction, commissioning and long term operations. For example, the hydropattern restoration feature may not be constructed and operated until the Miami Canal backfill and diversion of L-6 flows are complete. These features are expected to improve SRS inflow TP concentrations when complete. Depending on how the system responds to implementation of the first phase of the CEPP ALT4R, revisions to the sequencing of remaining features may be necessary. Given the magnitude of the hydrologic changes proposed in ALT4R2, this project presents some risk of future non-compliance with water quality criteria particularly in WCA-3 and at SRS. With the CEPP extended implementation schedule and initial construction efforts that focus on features with positive water quality impacts such as the Miami Canal Backfilling and the diversion of L-6 flows, there will be an opportunity to address potential water quality concerns before the addition CEPP flows are delivered through the system.

As the CEPP proceeds and data from individual projects are gathered, these data are expected to feed back into the CEPP adaptive management plan. Each individual component of the CEPP will require a Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) permit from the FDEP. Integration of adaptive management/operations/monitoring into the CEPP will help provide reasonable assurance associated with water quality issues and uncertainties. Ideally, adaptive management will be applied iteratively throughout the phasing of the CEPP to address issues early and allow for lessons learned to be applied for future phases. Commitment to adaptive management is key to moving this restoration project forward given the uncertainties associated with water quality.

F.7 REFERENCES

FDEP. 2012a. STA Everglades Forever Act (EFA) Watershed Permit (File No. 0311207-001) and Associated Consent Order (OGC 12-1149). Florida Department of Environmental Protection, Tallahassee, FL. September 10, 2012. http://www.dep.state.fl.us/water/wqssp/everglades/ecp-sta.htm.

FDEP. 2012b. STA National Pollutant Discharge Elimination System (NPDES) Watershed Permit and Associated Consent Order. Florida Department of Environmental Protection, Tallahassee, FL. September 10, 2012. http://www.dep.state.fl.us/water/wqssp/everglades/ecp-sta.htm.

FDEP and USEPA. 2012. Everglades Water Quality Restoration Framework Agreement between U.S. Environmental Protection Agency, Region IV, Atlanta, GA, and Florida Department of Environmental Protection, Tallahassee, FL. June 12, 2012.

SFWMD. 2010. 2010 South Florida Ecosystem Report. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2011. 2011 South Florida Ecosystem Report. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2012. 2012 South Florida Ecosystem Report. South Florida Water Management District, West Palm Beach, FL.